ARI Research Note 90-138

# A Measurement Concept for Assessing Corps Performance

Earl C. Pence, Robert L. Welp,
and David J. Stenstrom

Horizons Technology, Inc.



for

Contracting Officer's Representative
Steven R. Stewart

Executive Development Research Group
Thomas O. Jacobs, Chief

Manpower and Personnel Research Laboratory
Zita M. Simutis, Director

September 1990



United States Army
Research Institute for the Behavioral and Social Sciences

# U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

## A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

| | |
|---|---|
| EDGAR M. JOHNSON<br>Technical Director | JON W. BLADES<br>COL, IN<br>Commanding |

---

Research accomplished under contract for the Department of the Army

Horizons Technology, Inc.

Technical review by

Donna C. Angle

| Accession For | |
|---|---|
| NTIS GRA&I | X |
| DTIC TAB | ☐ |
| Unannounced | ☐ |
| Justification | |
| By | |
| Distribution/ | |
| Availability Codes | |
| Dist | Avail and/or Special |
| A-1 | |

### NOTICES

**DISTRIBUTION**: This report has been cleared for release to the Defense Technical Information Center (DTIC) to comply with regulatory requirements. It has been given no primary distribution other than to DTIC and will be available only through DTIC or the National Technical Information Service (NTIS).

**FINAL DISPOSITION**: This report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

**NOTE**: The views, opinions, and findings in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other authorized documents.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

# REPORT DOCUMENTATION PAGE

*Form Approved OMB No. 0704-0188*

**1a. REPORT SECURITY CLASSIFICATION**
Unclassified

**1b. RESTRICTIVE MARKINGS**
--

**2a. SECURITY CLASSIFICATION AUTHORITY**
--

**2b. DECLASSIFICATION / DOWNGRADING SCHEDULE**
--

**3. DISTRIBUTION / AVAILABILITY OF REPORT**
Approved for public release;
distribution is unlimited.

**4. PERFORMING ORGANIZATION REPORT NUMBER(S)**
--

**5. MONITORING ORGANIZATION REPORT NUMBER(S)**
ARI Research Note 90-138

**6a. NAME OF PERFORMING ORGANIZATION**
Horizons Technology, Inc.

**6b. OFFICE SYMBOL** *(If applicable)*
--

**7a. NAME OF MONITORING ORGANIZATION**
U.S. Army Research Institute

**6c. ADDRESS** *(City, State, and ZIP Code)*
10467 White Granite Drive, Suite 100
Oakton, VA 22124

**7b. ADDRESS** *(City, State, and ZIP Code)*
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

**8a. NAME OF FUNDING / SPONSORING ORGANIZATION**
U.S. Army Research Institute for the Behavioral and Social Sciences

**8b. OFFICE SYMBOL** *(If applicable)*
PERI-R

**9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER**
DAA-0985G0035

**8c. ADDRESS** *(City, State, and ZIP Code)*
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

**10. SOURCE OF FUNDING NUMBERS**

| PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT ACCESSION NO. |
|---|---|---|---|
| 62785A | 791 | 457 | C1 |

**11. TITLE** *(Include Security Classification)*
A Measurement Concept for Assessing Corps Performance

**12. PERSONAL AUTHOR(S)**
Pence, Earl C.; Welp, Robert L.; and Stenstrom, David J.

**13a. TYPE OF REPORT**
Final

**13b. TIME COVERED**
FROM 85/10 TO 87/10

**14. DATE OF REPORT** *(Year, Month, Day)*
1990, September

**15. PAGE COUNT**
156

**16. SUPPLEMENTARY NOTATION**
Steven R. Stewart, Contracting officer's representative

**17. COSATI CODES**

| FIELD | GROUP | SUB-GROUP |
|---|---|---|
| | | |
| | | |

**18. SUBJECT TERMS** *(Continue on reverse if necessary and identify by block number)*
Corps performance measurement REDCOM
Joint exercise simulation
System performance assessment

**19. ABSTRACT** *(Continue on reverse if necessary and identify by block number)*


This report introduces a measurement concept for assessing the performance of an Army corps participating in a joint exercise such as those conducted by the U.S. Readiness Command (REDCOM).

The operational objectives for corps-level organizations are identified through the review of the most recent Army doctrine and interviews with subject matter experts (SMEs) working on corps-level doctrine. Based on current doctrine, interviews with military SMEs, and a review of existing performance measurement systems, an information processing model of corps performance was developed. From this, data collection procedures and a measurement concept were developed initially and evaluated through application in the analysis of the Inchon Landing Operation conducted during the Korean War.

The measurement concept, data collection procedures, and validation plan presented in the report provide the blueprints for the development and validation of a corps performance measurement system that could be implemented using the REDCOM Joint Exercise Simulation


(Continued)

**20. DISTRIBUTION / AVAILABILITY OF ABSTRACT**
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

**21. ABSTRACT SECURITY CLASSIFICATION**
Unclassified

**22a. NAME OF RESPONSIBLE INDIVIDUAL**
Steven R. Stewart

**22b. TELEPHONE** *(Include Area Code)*
(703) 274-5482

**22c. OFFICE SYMBOL**
PERI-RO

**DD Form 1473, JUN 86** *Previous editions are obsolete.*

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

ARI Research Note 90-138

19. ABSTRACT (Continued)

System (JESS). This performance measurement system could then serve as the vehicle for providing feedback to participants in the REDCOM exercises.

A MEASUREMENT CONCEPT FOR ASSESSING CORPS PERFORMANCE

CONTENTS

CONTENTS (Continued)

## LIST OF TABLES

Page

## LIST OF FIGURES

CONTENTS (Continued)

SECTION 1
INTRODUCTION

## General

The present report introduces a measurement concept for assessing the performance of an Army corps participating in a joint exercise such as those conducted by the U.S. Readiness Command (REDCOM). The measurement system proposed is a dynamic rather than static system which can be tailored to provide feedback relevant to the unique aspects of different corps conducting different types of operations. The measurement concept is presented in a preliminary form and represents only the first step in the development of a comprehensive measurement and development program at the corps level in the Army.

## Background

The impetus for the development of the measurement concept in the current research effort comes from the growing recognition that a key component missing from many Army training systems is an adequate performance measurement system. A recent GAO report (1985) evaluating the National Training Center (NTC) suggests that many units training at the NTC are continuing to make the same mistakes made by earlier units. The authors of the GAO report suggest that a key factor impeding improvement in unit performance at the NTC is the lack of an adequate performance measurement and feedback system. The final report of the 1985 summer session of the Army Science Board (Training and Training Technology - Applications for AirLand Battle and Future Concepts, Peden and Barth, 1985) identified the same problem. The authors of the Army Science Board report note that a missing link degrading the effectiveness of many Army training and development programs is adequate performance measurement. This problem is noted as particularly acute at higher organizational levels where measurement of either individual or organizational performance is difficult.

The U.S. Army Research Institute has undertaken a number of research efforts designed to aid in development of performance measurement systems for the Army. The research to develop a measurement concept for assessing corps-level performance represents one facet of the research program of the Executive Development Research Group in the Manpower and Personnel Research Laboratory.

## Objective

The objective of the current research effort is to develop a performance measurement concept for assessing the performance of Army corps. A secondary objective is to present a plan for validating the measurement concept.

## Scope

As noted by Bernardin and Beatty (1984) and other experts in the area of performance measurement (Cummings and Schwab, 1973), the development of an effective performance measurement system begins with a clear understanding of the purpose of the measurement system. Performance measurement systems may be used to generate data for evaluation, training and development, or performance management and motivational objectives. The content and format of performance measurement systems are likely to vary depending on the primary purpose for which the system is constructed. Furthermore, as these experts note, it is not practical to develop a single performance measurement system which can be applied in all settings to provide data to achieve all purposes.

The performance measurement system developed in the current research effort is designed primarily as a tool to aid in the development of corps commanders and their staffs. As noted in FC 100-15, Corps Operations (1984), the development of the principal staff at echelons such as Corps and echelons above corps (EAC) is primarily the responsibility of the commander and his chief of staff. To accomplish this task, however, the commander must have the capability to exercise his staff in the execution of their wartime missions and receive feedback that will enable the commander and his principal staff to assess the effectiveness of their performance and identify the causes of problems which may occur during training.

## Corps-Level Training and Development

The development of corps commanders and training of the corps staff is a complex task. Realistic corps-level training is difficult to conduct simply because of the number of people and geographical area required to exercise a corps in the field. On the other hand, certain critical corps-level functions can be realistically exercised if one focuses on the capability of the corps commander and his staff to plan and coordinate the execution of major tactical operations. In describing the mission of corps, FM 100-5, Operations (1986), notes that, "Corps plan and conduct major operations and battles. They synchronize tactical activities including the maneuver of their divisions, the fires of their artillery units and supporting aerial forces, and the actions of their combat support and combat service support (CSS) units." (P. 185) As further noted in FM 100-5, the key to synchronization on the battlefield is planning conducted by commanders and their staff.

Given the importance of the planning and coordination functions of the corps commander and his staff, the performance measures developed in the current research effort are designed to provide feedback on these functions. The performance measurement concept is designed for implementation in the second phase of a three-phase training and development system. The three-phase system, suggested by General Paul Gorman (USA, Ret.), is currently in the concept development stage. As described below, the program would provide potential corps commanders with the opportunity to develop and practice the cognitive skills required for corps-level warfighting and provide corps commanders with the opportunity to exercise and assess their staff's ability to understand and execute the corps commanders' intent and concept of operation.

Phase 1: Development of General Officers' Frames of Reference

The first phase or segment of the training program will be designed for individual development of cognitive warfighting skills among general officers. This segment of the program requires the development of a computer-based system with databases, models, and networking capabilities. The system will allow asynchronous communications and sharing of information among participants in the development program. The system would be very similar to that discussed in the final report of the 1985 Professional Development of Officers Study Group (PDOS) (1985). The bulk of the development program would concentrate on individuals or small groups of general officers wargaming the planning and execution of corps-level operations using combat models and associated data bases. Appropriate feedback systems must be developed for the combat models keeping in mind that the objective of this phase of the program is to provide general officers with a frame of reference and limited experience in planning operations with the degree of complexity which exists at the corps level.

Phase 2: Corps Staff Development

The second phase focuses on the ability of the corps staff to positively affect synchronization on the battlefield through their understanding and execution of the commander's intent and concept of operation. This phase of the training and development program represents a shift in focus from upcoming corps commanders to existing corps commanders and their staffs and the objective of this phase is also quite different. This portion of the training program is currently under development and includes a family of combat simulation models such as Joint Theater Level Simulation (JTLS) and Joint Exercise Support System (JESS) which can serve as exercise drivers in corps level or higher Command Post Exercises (CPXs) or Command Field Exercises (CFXs). These exercises provide the opportunity for the corps commander and his staff to practice the planning of major tactical operations and the execution of coordination and logistical activities required during wartime. The exercises are typically joint exercises which provide opportunities for the commander and his staff to practice interfacing with other services. In fact, the primary focus of the exercises under development at REDCOM is the joint services interface.

A key factor currently missing from these large-scale exercises is an adequate performance feedback system which provides diagnostic information to the commander and staff. While the models used as exercise drivers provide combat outcome feedback, information on the performance of various elements of the corps staff which contribute to combat outcomes is provided only on an ad-hoc, subjective basis. The exercise driver models will need to be supplemented by additional performance measurement tools which provide the data required to link staff actions to combat outcomes and provide feedback on the level of performance of various staff elements. The development of a measurement concept for such a performance measurement system is the primary objective of the current research effort.

Phase 3: Implementation of Operations in the Field

The third and final phase of the training and development system for corps commanders and their staffs would involve the use of corps-level training exercises without troops (TEWOTs). These exercises would allow the corps staff to practice implementation of the their plans in a field environment with distributed command posts (CPs). A corps-level TEWOT could be conducted with small elements representing units down to battalion spread over a geographic region reflecting the typical area of operation of a corps. The logistical, navigational, and communication problems introduced by this field environment would provide a more reasonable assessment of the corps-staff's ability to plan and execute operations in combat. The information gained from a performance measurement system in this type of exercise would provide feedback focused on staff implementation/execution of the commander's plan of operations as well as the staff's ability to communicate and coordinate in a field environment.

Performance feedback systems will be required in all three phases of the corps training and development program. It is important to note, however, that the current research effort is focused on the development of a performance measurement concept for only the second phase of the training system.

Organization of the Report

The remaining sections of the report describe: (1) the research approach followed in the current effort; (2) the performance measurement concept developed in the effort; (3) an application of one aspect of the performance measurement concept to a historical military operation; and (4) a plan for validating the measurement concept within the context of joint exercises conducted at REDCOM. The measurement concept presented in the report is complex in nature. To facilitate the communication of this concept, certain material has been placed in appendices rather than included in the text.

Section 2 of the report describes the research approach followed in developing the performance measurement concept. This approach was based on a seven step process model for the development of an organizational performance measurement system. The seven steps in the model include:

1. Identification of the organizational purpose/objectives of the organizational element of interest

2. Identification of the outcomes and products produced by the organizational element that are related to the accomplishment of its organizational objectives

3. Development of a performance model to identify individual, organizational, and environmental factors impacting on the quality of the outcomes and products identified in (2) above

4. Development of criterion measures to assess quality of the outcomes/products of the organizational element

5. Development of measurement procedures to assess performance factors identified in the performance model (diagnostic measures)

6. Development of a criterion and performance measurement feedback system

7. Validation of the criterion and performance measures and assessment of the utility of the feedback system

The seven step process and specific research activities in the current study are both presented in this section. The seven step model described in Section 2 provides the basis for the research approach used in the study as well as the basic structure for the organization of the remainder of the report.

Section 3 describes the findings from the review of Army doctrine and interviews with military SMEs in the area of corps-level doctrine. The focus of this section is on the identification of the organizational purpose and objectives of the Army Corps. This represents the first step in the development of an organizational performance measurement system.

Section 4 of the report presents potential criterion dimensions and an information processing model of corps performance. This section briefly summarizes the review of published literature on several existing performance measurement systems which are described in more detail in Appendix B. The identification of the potential outcome measurement dimensions and development of the performance models are the second and third steps in the general model for developing performance measurement systems.

Section 5 of the report provides a detailed discussion of the concept of synchronization. This concept is the major performance construct underlying the corps performance measurement system.

The conceptual discussion of synchronization in Section 5 is immediately followed by a detailed analysis of a synchronized corps-level operation in Section 6. The military operation, the Inchon Landing Operation of the Korean War, is analyzed using synchronization measurement tools which are part of the general performance measurement concept developed in the current research effort.

Section 7 of the report presents the general performance measurement concept which is the primary focus of the current research effort. The concept is discussed in terms of a measurement strategy as well as the major structural components in the measurement concept.

Section 8 presents a detailed discussion of the data collection, analysis and synthesis required to implement the measurement concept described in Section 7. The data collection plan is set within the context of the joint exercise environment at REDCOM. An overview of the REDCOM exercise program is presented in Appendix C of the report.

The final section of the report, Section 9, presents a general discussion of validation of performance measurement systems as well as a specific plan for validating the corps performance measurement concepts within the REDCOM context.

## SECTION 2
## RESEARCH APPROACH

### The Concept Development Process

The primary objective in the current research effort was the development of a measurement concept for assessing the performance of corps-level organizations. Therefore, the research approach employed in the study was primarily a concept development process. The approach was based on the seven steps, described in Section 1, for developing an organizational performance measurement system. The process model was developed through earlier research by the first author of this report.

The seven steps are essentially a list of tasks which must be completed to develop an operational performance measurement system. While the development of the performance measurement concept in the current research effort did not require completion of all seven tasks, the model provided a framework for development and evaluation of the measurement concept. Figure 2-1 presents a schematic of the seven step process and the tasks completed in the current research effort which addressed each of the seven steps. Each of the seven steps in the general model and the corresponding research tasks completed in the current study are described in more detail below.

### Step 1: Identification of Organizational Objectives

The first step in the general model for developing organizational performance measurement systems is to identify the purpose and objectives of the organizational element of interest. It is important to note that identification of the objectives for a particular element of an organization usually requires collection of information from outside of the element of interest.

The identification of the general purpose and organizational objectives for Army corps was accomplished through three research tasks: review of current Army doctrine, interviews with SMEs working on corps-level doctrine for the Army, and review of selected historical examples of corps-level operations in WWII and the Korean War.

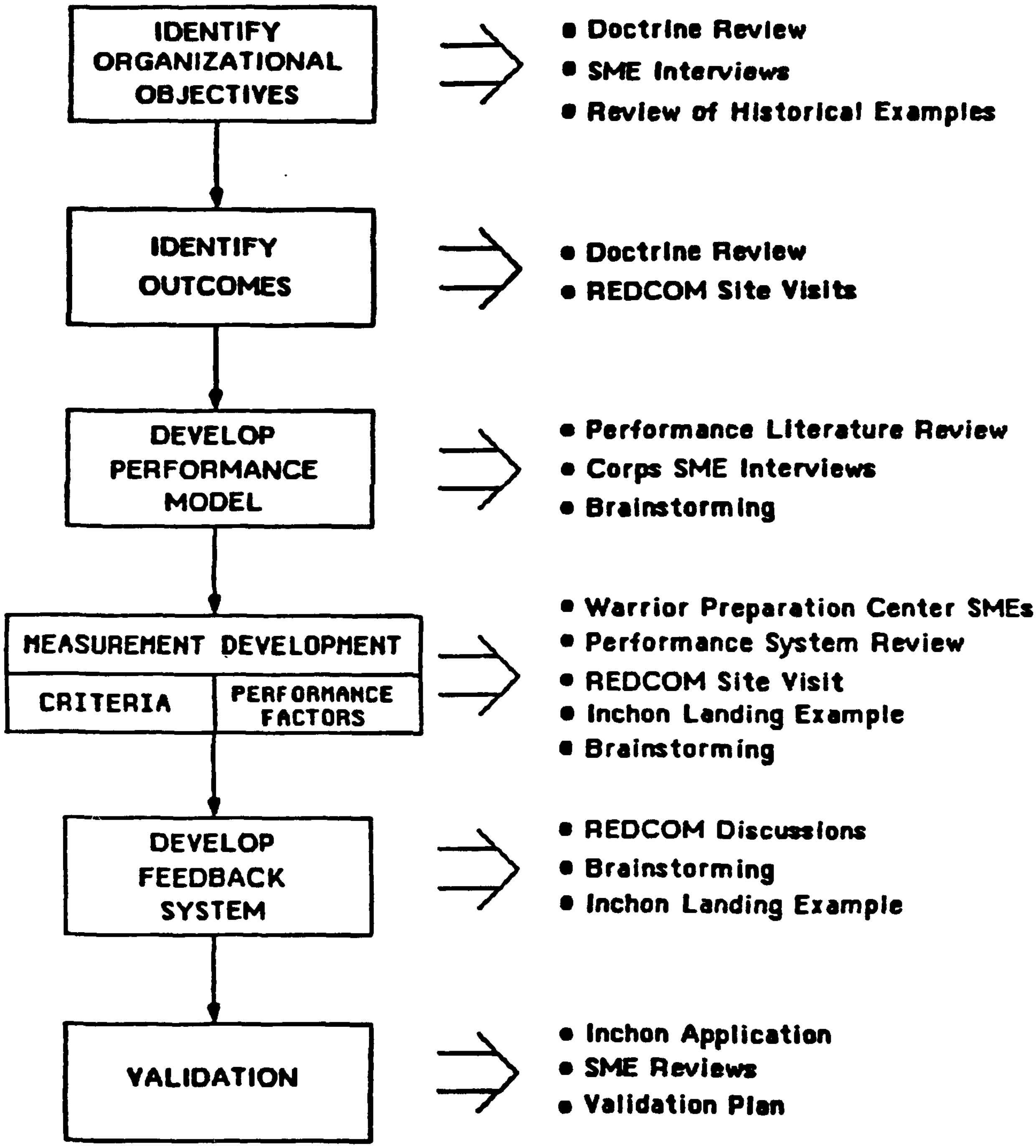



FIGURE 2-1. Organizational Performance Measurement System: Development Process Model

### Step 2: Identification of Organizational Outcomes/Products

Once the organizational purpose and objectives of the element or unit have been established, the next step is to identify potentially measurable outcomes and/or products which contribute to achievement of the organizational objectives. A critical factor in successful completion of this task is the identification of outcomes and products that are directly related to the actions of the element of interest.

In the current research effort, the identification of the products or outcomes produced by Army corps was a difficult task. The decision was made to focus on the corps commander and the corps staff as the primary organizational elements of interest. Three research tasks were undertaken to identify the products or outcomes directly associated with the corps commander and staff. These tasks included the review of current Army doctrine related to corps staff operations, brainstorming sessions among the core research team and selected SMEs, and a site visit to identify potentially measurable outcomes in the joint exercises conducted at REDCOM.

### Step 3: Development of a Performance Model

This step involves the development of a performance model delineating the individual, organizational, and environmental factors impacting on the performance of the organizational element of interest. Such a model also includes descriptions of the relationships between these performance factors and may need to be expanded to include the relationship of the products/outcomes of the organizational element of interest to the larger organizational performance objectives.

The performance model and performance factors identified in this third step should be generic in nature. That is, the model should be applicable to the performance of similar organizational elements in a variety of similar situations. For example, while the performance factors should remain stable, the measurement procedures developed to assess the performance of a corps staff may differ across settings. That is, data collection opportunities and situational requirements may dictate that operationalization of a particular performance factor through measurement procedures will change as one moves from a CPX to an FTX. This is one reason that the development of criterion and performance measures are treated as steps separate from the development of the performance model and identification of performance factors.

The development of a corps performance model was a key step in the current research effort. As will be described later, the model focuses on the synchronization construct underlying AirLand Battle doctrine. Three tasks in the research approach contributed to the development of the performance model. The first of these tasks was a review of the literature on performance measurement systems developed for Army units and headquarters staffs. The second task was to interview SMEs with command experience at the corps-level or above. The third research task was extensive brainstorming sessions held by the research team, including the presentation and critique of initial models of corps performance factors.

Step 4: Development of Criterion Measures and Performance Measures

The fourth step in the general model for developing a performance measurement system is the development of the actual criterion measures which can be used to evaluate the quality of ithe outcomes or products produced by the organizational element. This process may involve development of two levels of criterion measures -- measures for both direct and indirect outcomes related to performance of the element of interest. These criterion measures provide data as to how well the element performed. They provide answers to questions related to what happened but not why a particular level of performance occurred. To answer the latter question, one must move to the fifth step in the development of the performance measurement system -- development of measurement procedures to assess the performance factors identified in the performance model.

Step 5: Development of Measurement Procedures

The development of measurement procedures to accurately assess factors influencing the quality of outcomes produced by an organizational element is especially critical for a performance measurement system designed for training purposes. The data provided by these measures forms the basis for diagnostic feedback required for improving organizational performance. As noted above, the exact nature of the measurement or data collection procedures will vary with the context in which the data are collected.

While the current study did not require the development of operational criterion and performance measures, the concepts for such measures are the primary products of the research effort. The research approach used in the current study combined the fifth and sixth steps into a general measurement procedure development task. Five research tasks were included in the completion of this aspect of the study. The first of these tasks was the literature reviews of Army doctrine, historical examples of corps-level operations, and existing performance measurement systems. The second task was to interview SMEs who had worked on the development of corps-level performance measures for the Warrior Preparation Center (WPC), a joint exercise center for the Army and Air Force. The third task was a second site visit to REDCOM to conduct interviews and receive a demonstration of the Joint Exercise Simulation System. The purpose of this visit was to gather detailed information on performance data which might be collected during REDCOM exercises involving Army Corps. The fourth research task was a series of brainstorming sessions designed to synthesize information collected from the literature reviews, site visits, and SME interviews. The final research task was a preliminary application of some of the measurement concepts to the analysis of the Inchon Landing Operation conducted by General Douglas MacArthur during the Korean War.

Step 6: Development of a Feedback System

After the actual data collection/measurement procedures have been established for an operational performance measurement system, attention must then be devoted to the development of a feedback system for providing data to the interested parties. The content and format of the feedback will, of course, be idirectly related to the purpose of the performance measurement system. When the primary purpose is training, particular attention must be paid to presentation of the diagnostic feedback in a manner which is not likely to create defensive reactions among members of the organizational element. It is best to keep the feedback as objective as possible. Data should be presented which allows the members to objectively evaluate the effectiveness of their own performance. The diagnostic feedback should be used as a vehicle for identifying problems and potential solutions.

No operational feedback system was developed in the current research effort. However, the discussion of the performance measurement concept includes the topic of providing feedback to the corps commander and the corps staff. Three research tasks addressed the issue of the feedback mechanisms required in a measurement system for addressing corps performance. These tasks included the discussions at REDCOM, the research team brainstorming sessions, and the application of the synchronization measurement concept to the analysis of the Inchon Landing Operation.

Step 7: Validation of the Performance Measurement System

The final step in the development of a performance measurement system is the validation of the criterion and performance measures and assessment of the utility of the feedback system. Ideally, the criterion and performance measures would be validated by collecting data over time and across different organizational elements. These data would be correlated to independent performance indicators as well as examined for internal consistency in relationships among performance factors and criterion measures contained within the performance measurement system. Data, in the form of trainee reaction measures regarding utility of feedback, are also critical in the evaluation of a performance measurement system designed for training.

Since no operational performance measures were developed in the current research effort, no empirical validation tasks were included in the research approach. Initial evaluation of the feasibility of the performance measurement concepts developed in the study was accomplished through the application of the concepts to the analysis of the Inchon Landing Operation and through reviews by SMEs familiar with corps operations. In addition, the report contains a detailed discussion of validation strategies that could be used in evaluating a measurement system based on the concepts developed in the current effort.

Execution of the Research Approach

Figure 2-2 provides a schematic overview of sequence in which specific research tasks were conducted in the current study. The manner in which each of the major research activities identified in Figure 2-2 was executed is briefly described below.

It should be noted that throughout the entire process the contractor and the Contracting Officer's Representative (COR) engaged in a series of intensive brainstorming sessions to generate and evaluate alternative measurement concepts and potential methodologies for implementing the concepts.

The research process began with three activities which were conducted in parallel. These activities included a review of several bodies of literature, brainstorming sessions between the contractor, the COR, and various SMEs, and site visits and interviews with individuals involved in the various aspects of doctrine development and corps-level exercises.

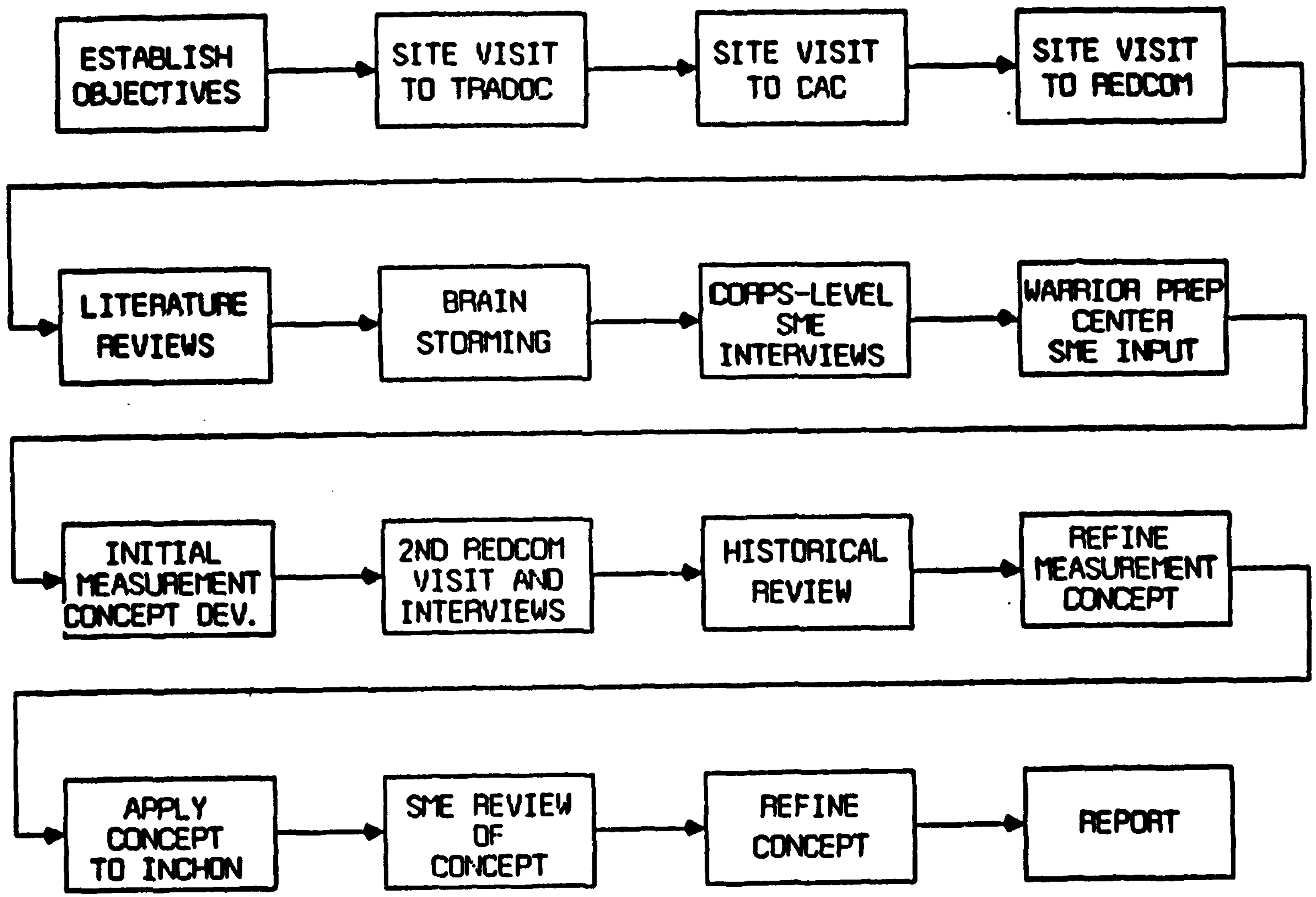



FIGURE 2-2. Research Process.

## Literature Reviews

Three bodies of literature were reviewed as part of the measurement development process. The areas on which the literature reviews focused were Army doctrine, recent historical examples of corps-level operations, and previous performance measurement systems developed for the Army. The research team was well versed in the area of performance measurement theory and methodology. The primary objective for conducting the literature reviews was to ensure that the measurement system developed in the current research effort would have a sound military basis and provide feedback which was meaningful and useful to corps commanders and their principal staff officers.

The review of military doctrine had two foci: First, the latest operational doctrine for how the Army plans to fight was reviewed in detail. The foundation for this doctrine is the AirLand Battle doctrine presented in the 1986 version of FM 100-5, Operations. In addition to an intensive review of FM 100-5, the authors reviewed a number of articles discussing the history and issues surrounding AirLand Battle doctrine which have appeared in professional military journals such as Military Review. The second focus of the review of military doctrine was directed at the identification of the specific roles, objectives, and tasks to be accomplished by corps-level organizations. Documents reviewed for this purpose included FC 101-55, Corps and Division Command and Control (1985); FC 100-15, Corps Operations (1984); and FM 101-5, Staff Organization and Operations (1984).

The review of historical examples of corps-level operations focused on operations conducted during WWII and the Korean War. The historical accounts were examined to identify the nature of corps-level operations, the nature of the planning involved, critical factors impacting on success or failure of the operations, etc. As the measurement concept developed, the review of corps-level operations centered on operations which exemplified synchronization, one of the four tenets underlying AirLand Battle doctrine. The Inchon Landing conducted by General Douglas MacArthur during the Korean War was studied in extensive detail and used as a demonstration of the application of the measurement methodology for assessing synchronization.

The review of existing measurement systems focused on previous attempts to assess the performance of commanders and their staffs. The information collected during the review was used to assess the viability of the measurement concepts developed in the current effort. The review was also used to identify potential problems which the current system needed to avoid or solve.

### Subject-Matter Expert Interviews

Concomitant with the literature reviews, the research team met on separate occasions with two subject-matter experts (SMEs) with command experience at the corps level or above. The interviews were highly interactive, semi-structured and ended in brainstorming sessions. One of the interviews lasted approximately 1/2 day while the other lasted for approximately two days. The SMEs met with a group of approximately four to six researchers. The interviews focused on three topics: the critical tasks and objectives of corps-level organizations, methods to assess corps performance, and methods for corps-level training. Both interviews were tape recorded.

### Site Visits

In addition to the two SMEs with command experience at the corps level or above, the research team made a number of site visits to interview various personnel involved in the development of corps-level doctrine or the development and implementation of corps-level exercises. The doctrinal experts were interviewed at the Combined Arms Center (CAC) at Ft. Leavenworth, KS. and at TRADOC Headquarters at Ft. Monroe, Va. The primary focus of these interviews was on the current status of doctrine related to corps operations and mission essential tasks at the corps level. The primary finding from the interviews with doctrinal experts was that corps-level doctrine is in a state of transition.

The interviews with individuals involved in the development and implementation of corps-level exercises were conducted on two visits to REDCOM. The first visit was exploratory in nature and served to focus the research effort on development of a performance measurement system for implementation in the joint exercises conducted at REDCOM. The second set of interviews were structured with a focus on collection of specific information about the nature of the Bold Venture 87 and later exercises to be conducted by REDCOM. A copy of the questions addressed during the second REDCOM visit is included in Appendix A. The research team interviewed individuals involved with the development, control, and evaluation of the Bold Venture 87 exercise. All of the questions contained in Appendix A were answered during the interviews.

Input from Researchers from the Warrior Preparation Center

Besides REDCOM, the only location at which joint exercises are conducted using computer models as exercise drivers is at the Warrior Preparation Center in Europe. The research team for the current effort met with Army and Air Force research psychologists who had worked on performance measurement systems for the Warrior Preparation Center. The meetings focused on identification of potential problems and solutions related to performance measurement in large-scale joint exercises.

Application of Synchronization Measurement Concept

As part of the evaluation of the feasibility of the measurement concept developed in the current effort, the methodology to be used in assessing synchronization of a corps-level operation was tested using detailed accounts of the Inchon Landing Operation. The process and results of this application are described in detail in Section 6 of the report.

Review of the Concept by SMEs

The final step in the development of the corps performance measurement concept was a detailed review of the concept by a military subject-matter expert currently working on the development of an Army-wide training strategy.

The execution of the research tasks described above provided the research team with a wealth of information concerning corps operations. The analysis and synthesis of the information produced the findings described in Sections 3 through 9 of the report. The next section of the report describes the findings regarding the objectives of the Army corps as identified in the Army's operational doctrine.

## SECTION 3
## IDENTIFICATION OF THE PURPOSE AND OBJECTIVES OF THE ARMY CORPS

### General

The Army Corps is the organizational element of interest for the current research effort. While it is important to recognize that each Army Corps has specific objectives and contingency plans which make it unique, one can identify the general role which doctrine suggests that corps-level organizations play in warfighting. The results of the research tasks conducted to identify the general organizational purpose and objectives of Army Corps are presented below.

### Review of Doctrine

Before discussing the specific objectives and roles of corps-level organizations in warfighting, it is important to briefly review the nature of the Army's operational concepts for the modern battlefield. FM 100-5, Operations is the doctrinal manual which presents the concepts which underlie the objectives and roles of organizational elements at all levels within the Army. As noted in the preface to the 1986 edition of FM 100-5:

> FM 100-5, Operations, is the Army's keystone warfighting manual. It explains how Army forces plan and conduct campaigns, major operations, battles, and engagements in conjunction with other services and allied forces. It furnishes the authoritative foundation for subordinate doctrine, force design, materiel acquisition, professional education, and individual and unit training. It applies to Army forces worldwide, but must be adapted to the specific strategic and operational requirements of each theater..... (p. i)

It is important to recognize that the basic operational concepts underlying Army doctrine as presented in FM 100-5 have undergone considerable change during the last 10 years. Prior to the mid-1970s, the FM 100-5 presented a doctrine which emphasized both firepower and maneuver. In 1976, a new version of the FM 100-5 was published which tended to focus on the lethality of new weapon systems and downplayed the role of maneuver on the modern battlefield. Instead, the manual presented a doctrinal approach to warfighting referred to as the "active defense".

The active defense doctrine reflected a political stance that the United States would engage in war only for defensive purposes (with a primary focus on heavy forces in Europe) and a military stance that lethality of current weapon systems required fighting from well-prepared defensive positions. The rationale for the military stance was based largely upon evaluations of the 1973 Middle East War and various computer simulations which focused attention on firepower as the primary determinant of victory on the modern battlefield. As noted by LTC Paul T. DeVries, US Army (DeVries, 1983) it is ironic that a doctrine which largely neglects maneuver as an essential element of combat power would be derived from the experience of the Israelis in 1973. The decisive factor which enabled the Israelis to achieve victory in that war was superior maneuver.

Critics of the active defense doctrine rapidly appeared both inside and outside of the Army and included members of Congress such as Sen. Gary W. Hart (D-Colorado). Critics of the doctrine presented in the 1976 version of the FM 100-5 noted that the manual presented an attrition-based approach to warfighting. The Army recognized the need to revise the doctrinal concepts in FM 100-5 and published a new version of the manual in 1982. In a Military Review article introducing the 1982 version of FM 100-5, Wass de Czege and Holder (1982) state that the reason for the publication of the new FM was simply that:

> Army commanders became convinced as a result of their field training and war games that they would be unable to defeat the Soviets using the doctrine of 1976. These commanders believed that they could beat the leading Soviet echelons using the "active defense" but that the initial battles would render our units ineffective while leaving Soviet follow-on forces intact with complete freedom of action. (p. 53)

Wass de Czege and Holder (1982) also note, however, that the concepts presented in the 1982 version of FM 100-5 represented an evolutionary, not revolutionary, change in doctrine. That is, the 1982 version of FM 100-5 incorporated the strong points of the 1976 version, reemphasized maneuver and the principles of war which had been contained in earlier versions of FM 100-5, and presented new material focused on the operational level of warfighting and the importance of integrating air and ground forces. The doctrine presented in the 1982 version of FM 100-5 has been labeled AirLand Battle doctrine.

Essentially, the 1982 version of FM 100-5 presented a more balanced view of the modern battlefield with a major emphasis on the role of maneuver in battle. The doctrine distinguished between the operational and tactical levels of warfighting and stressed the importance of the operational level to success on the modern battlefield. The manual also placed considerable emphasis on the intangible aspects of combat power such as leadership, cohesion, and training.

The central theme in the 1982 version of FM 100-5 is the AirLand Battle operational concept. The manual stresses the importance of initiative and bold actions to be taken by commanders at all levels. Four tenets are cited as underlying AirLand Battle doctrine: initiative, depth, agility, and synchronization. The manual suggests that the way to win on the modern battlefield is to seize and maintain the initiative and shape the battle in a proactive manner. The key to seizing and maintaining initiative according to FM 100-5 is to attack and fight the enemy in depth. Such fighting in depth requires the synchronization of all elements of combat power plus the development of mental and operational agility which allows one to make adjustments in plans and operations in response to the rapidly changing battlefield.

The 1982 version of FM 100-5 touched upon the concept of the operational level of war in only a superficial and global manner. The manual did note that corps-level organizations are heavily involved in the operational level of warfighting. The operational level was defined as the interface between strategic and tactical levels and involves the planning and execution of campaigns and major battles with an emphasis on capitalizing on the outcomes of tactical operations. The 1982 version of FM 100-5 also noted that corps-level organizations were the primary level for coordination of information and assets required to fight the "deep battle" discussed in AirLand Battle doctrine.

The 1982 version of FM 100-5 and AirLand Battle Doctrine has generated continued debate on doctrinal issues in professional military publications such as Military Review. A review of the articles discussing these issues indicates that the emphasis on maneuver as an element of combat power has been greeted with both enthusiasm (Doefel, 1982; Wass de Czege and Holder, 1982) and concern (Maginnis, 1986; Bates and Quinn, 1986; Hall, 1986). The concern has been voiced in the form of a call for balance between emphasis on maneuver and firepower and the need to recognize the demands placed on leaders and units by the new AirLand Battle doctrine.

The debate in the military journals also indicates that three aspects of the AirLand Battle doctrine have stimulated a great deal of interest and need for clarification. These areas include the concepts of operational level of warfighting, fighting the deep battle, and definition of the concept of synchronization. In response to the continued doctrinal debate, the Army has revised FM 100-5 again and released a new 1986 version of the doctrinal manual. This latest version represents a fine-tuning of the 1982 version which accomplishes the following goals (Richardson, 1986):

- The manual more clearly distinguishes between the tactical, operational, and strategic levels of war and expands the discussion of the operational level of war;
- More fully explains the deep battle concept and the role of synchronization in combat operations;
- Provides a more balanced view of offensive and defensive operations;
- More fully discusses the relationship between Army and Air Force operations at the theater level;
- Clarifies misperceptions concerning the relationship of AirLand Battle doctrine and NATO doctrine.

## The Role and Objectives of Army Corps

The 1986 version of FM 100-5 provides somewhat more detail on the role of the corps in the AirLand Battle. As noted earlier, the corps functions at the interface of the tactical and operational levels of war. According to FM 100-5 (p. 185):

> The corps plans and conducts major operations and battles. They synchronize tactical activities including the maneuver of their divisions, the fire of their artillery units and supporting aerial forces and the actions of their combat support and CSS units. ... When employed alone, they may exercise operational as well as tactical responsibilities.

FM 100-5 also suggests that the corps is the lowest level at which intelligence and air assets required to plan and conduct major deep operations are available. The corps and division levels are also the primary points at which the close, deep, and rear battles are synchronized.

More detailed information on the role of the corps in the AirLand Battle can be found in FC 100-15 (1984), a preliminary draft of FM 100-15, Corps Operations. According to this publication, the critical functions played by corps in the AirLand Battle include:

- Providing the link between tactical operations and strategic objectives
- Fighting the enemy throughout the corps' area of operations with maneuver forces or firepower
- Maintaining surveillance within and acquiring information beyond the corps' area of operations to provide an accurate picture of those enemy forces that can affect the current and future battles
- Supporting the battle with combat support and combat service support forces
- Monitoring closely air support availability and distributing close air support (CAS) sorties for the close-in battle, requesting missions for tactical air reconnaissance (TAR), and selecting targets and providing target information for battlefield air interdiction (BAI) missions within the corps area of operations.

The FC 100-15 notes that the corps commander "develops and orchestrates the operational plan to fight the deep battle, the close-in battle, and the rear area battle simultaneously. He influences the battle by dividing up the battlefield, through the allocations of assets, and by the synchronization of the AirLand Battle within his area of responsibility." (p. 3-8). The field circular stresses that the synchronization of the battle depends on subordinates' understanding of the commander's concept and notes that synchronization "is a battle coordination function accomplished by the staff" (p. 3-15).

FC 100-15 suggests that the corps-level is the focal point for fighting the AirLand Battle because AirLand Battle doctrine is primarily an operational-level doctrine. Two additional reasons are cited for corps being the optimal level for fighting the AirLand Battle. First, the corps has the ability to continually gather and process intelligence through its interfaces with national, Air Force, Navy, and organic surveillance systems. Second, the corps appears to be the best level for synchronization of fires from ground, air, and naval forces.

The bottom line which can be drawn from the review of evolving Army doctrine for corps operations is that the corps is the primary level for implementation of the operational concepts found in the AirLand Battle doctrine presented in FM 100-5. Perhaps the most critical function detailed for the corps is the synchronization of close-in, deep, and rear area battles as well as the synchronization of ground, air, and naval forces and intelligence.

## Interview Results

The findings from the interviews with individuals working in the area of corps-level doctrine at TRADOC and CAC indicated that doctrine at this level is in a state of transition. The interviews also indicated a recognition that the issues surrounding corps-level operations are extremely complex. Unfortunately, the doctrinal SMEs interviewed had fairly limited personal experience at the corps level. For this reason, the decision was made to interview additional SMEs with experience at the corps level and above.

The results of the interviews with two retired General Officers, both of whom are noted for their innovative ideas in the areas of leadership and training at the large-unit level, reinforced much of what was found in the doctrine literature review. Both individuals noted that the corps is an extremely complex organization which presents major challenges for its commander. The SMEs noted that the corps commander needed a different perspective or frame of reference than that required to command a division.

The SMEs noted that a critical task which must be performed by the corps commander is to clearly communicate his intent and concept of an operation. In the view of both SMEs, this is an essential ingredient for the execution of synchronized operations. One noted that the corps commander had to ingrain his intent in his staff and essentially shape and mold his staff to fit his style of leadership and concept of operations. Both SMEs also suggested that one of the most critical performance factors to be considered in examining corps performance is the corps' ability to process information in a timely and accurate manner.

## Summary

After completing the interviews with the corps-level SMEs and finishing the review of Army doctrine and related publications, the research team had successfully identified the general objectives of corps-level organizations within the context of AirLand Battle doctrine. The review of doctrine indicated that some of the key objectives to be performed by corps-level organizations include:

- Synchronization of the close-in, deep, and rear area battles
- Fighting the enemy throughout the corps' area of operations
- Synchronization of air, ground, and naval forces
- Maintaining surveillance within and acquiring information beyond the corps' area of operations to provide an accurate picture of enemy forces
- Support the battle with combat support and combat service support forces

While the objectives described above are not assumed to be exhaustive and are primarily focused on the corps' wartime mission, they were deemed as adequate to provide the basis for further development of the corps performance measurement system for implementation within the context of the joint exercises conducted by REDCOM. The next step in the development of the corps performance measurement system was to identify potential outcome measures related to the objectives identified in the literature review and interviews.

# SECTION 4
# POTENTIAL CRITERION MEASURES AND A CORPS PERFORMANCE MODEL

## General

The second and third steps in the development of an organizational performance measurement system are the identification of outcome measures related to the objectives and purpose of the organizational element of interest and the development of a performance model which identifies individual, organizational, and environmental factors which impact on these performance outcomes. In the case of complex organizational elements, it may be necessary to perform these two steps in tandem. The research team in the present effort found this to be the case in the attempt to identify performance outcomes for Army corps.

## Potential Criterion Measures

Examination of the objectives identified at the end of Section 3 suggests that outcome measures related to the corps' primary objectives may be classified into three related categories: The first category is combat outcome measures which are related to the "bottom line" of mission accomplishment. These measures would include those related to casualties inflicted on the enemy, casualties suffered, territory captured, etc. The second category of outcome measures would be measures related to logistics and efficient distribution, management, and use of equipment, supplies, etc. This second category essentially represents an indicator of efficiency of corps operations while the first is more directly related to overall effectiveness of the operation. The final category of measures or products are those related to information processing and intelligence analysis. A number of information-related products are required in planning and executing a synchronized operation. Considering the major emphasis on corps-level synchronization of various aspects of combat operations, evaluation of such information products and processes represents a critical dimension of corps performance.

Details of the nature of the measures and types of data to be collected for the outcome measures noted above will be presented in a later section of the report. At this point, it is simply important to note that assessment of the final outcome of corps-level performance will require multiple criterion measures. Furthermore potential criterion measures fall into the categories of battle outcome measures, logistics and supply efficiency measures, and information products and processes.

A major problem in dealing with criterion measures for an organization such as an Army Corps is the fact that bottom-line outcome measures such as combat outcomes represent the effects of actions taken at various echelons in the organization. As illustrated in Figure 4-1, bottom-line outcome/combat outcome measures reflect the nested effects of corps, division, brigade, battalion, company, and platoon actions. The exact nature of the effects produced at each level and the relationships between effects across levels is largely unknown. One can probably suggest that the effects of planning and distribution of resources have their impact on combat outcomes in primarily a top-down manner. On the other hand, effects which occur as a result of errors in execution are likely to have their effects in a bottom-up manner. This is not to say that errors in execution of a mission at corps level will not have a major impact. Rather, it suggests that the inability of individual soldiers or small units to perform their missions will spell disaster for even the best-planned operations. Likewise, outstanding performance at the individual and small-unit level will be wasted if such efforts do not occur as part of a synchronized plan which has been well coordinated and resourced from upper command levels.

If the organizational element of interest is the corps staff, intermediate outcome measures which are related to battle outcomes should be identified. The intermediate performance indicators should be directly related to the corps staff's actions which impact on the bottom-line battlefield outcomes through the actions of echelons below the corps or through elements of other organizations not organic to the corps.

## A Corps Performance Model

The development of a multi-echelon model of combat performance for all levels at or below corps is a task beyond the scope of the current effort. For this reason, the use of bottom-line combat outcome measures as the primary measure of corps performance is unlikely to provide the type of information required for diagnostic feedback for training purposes. This is not to say that such outcome measures are not important. Instead, it suggests that considerable research is required to provide a more complete model of combat performance to sort out the contribution of actions at various echelons to final combat outcomes.

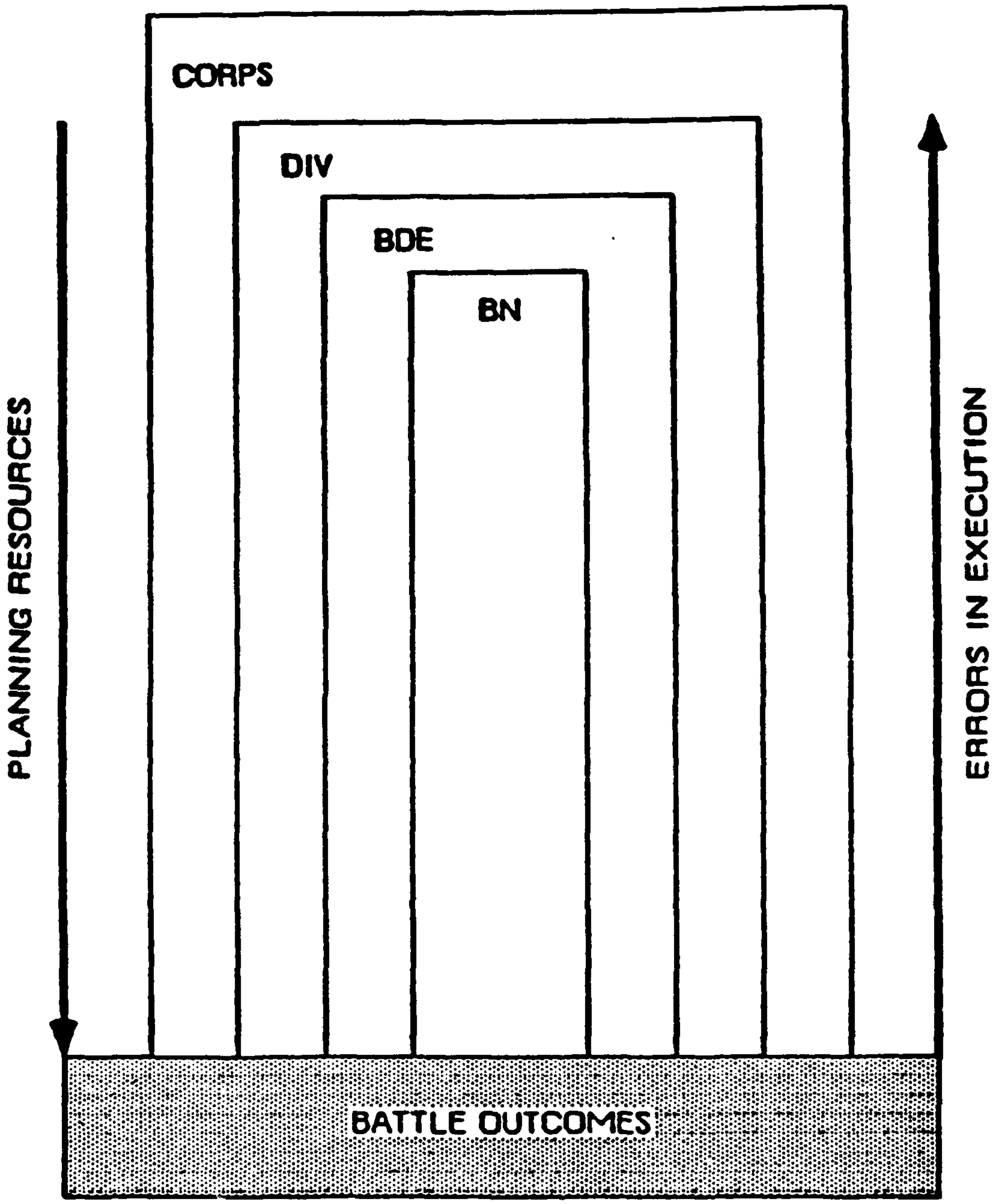



FIGURE 4-1. Nested Unit Performance Effects

A more realistic approach, and the one adopted in the current effort, is to focus attention on those products or outcomes which directly reflect the actions of individuals at the corps level. The review of doctrine and the discussion above suggests that the appropriate measures of interest in assessing corps-level performance would be measures related to planning, information processing, coordination, and resource allocation. Furthermore, a model of corps-level performance which focused on direct outcomes of corps-level actions would be primarily an information processing model.

Figure 4-2 provides an illustration of a greatly simplified model of information processing dynamics at the corps level. The model suggests that factors affecting the performance of the corps include accuracy of information coming into the corps from echelons above the corps, other services, organic corps intelligence assets, and spot reporting by subordinate tactical elements in the corps. Furthermore, individual and organizational communication, information processing, and decision making variables will impact on performance by affecting the quality, timeliness, etc. of information processing within the corps staff itself. As shown in Figure 4-2 all of these variables should impact on the initial plan and subsequent ability of the corps staff to coordinate execution of a planned operation. These two factors will, in turn, impact on the degree of synchronization which is displayed in the actual execution of the operation.

The successful execution of planned events in an operation will reflect the effects of all echelons down to the platoon and squad level in actual combat. In CPXs and other combat simulation exercises, the outcomes are the products of the effects down to the lowest level players and the algorithms used in combat models and simulations. However, the degree to which a plan provides for synchronized actions, the degree to which the corps commander's intent and concept of the operation is communicated to the division level, the degree to which timely information is provided to division level, and the extent to which adequate resources are distributed to division level are direct measures of the performance of a corps commander and his staff.

Figure 4-3 presents a modified version of the corps performance model which focuses on synchronization of operations as the primary outcome measure of corps performance. In this model, the initial factor impacting on corps performance is the information provided to the corps commander and the corps G-3, by the G-2 and EAC. The G-3

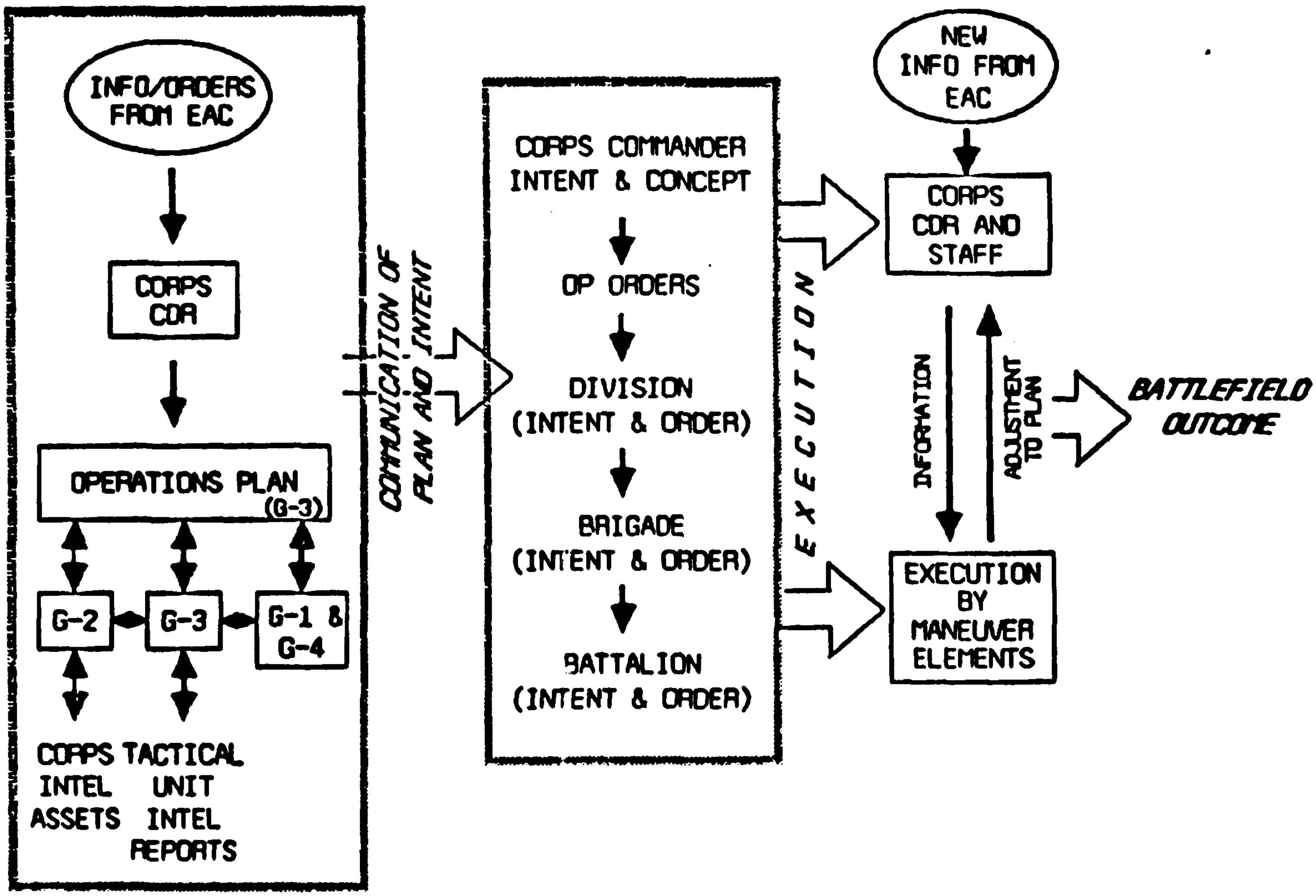



FIGURE 4-2. Initial Corps Performance Model

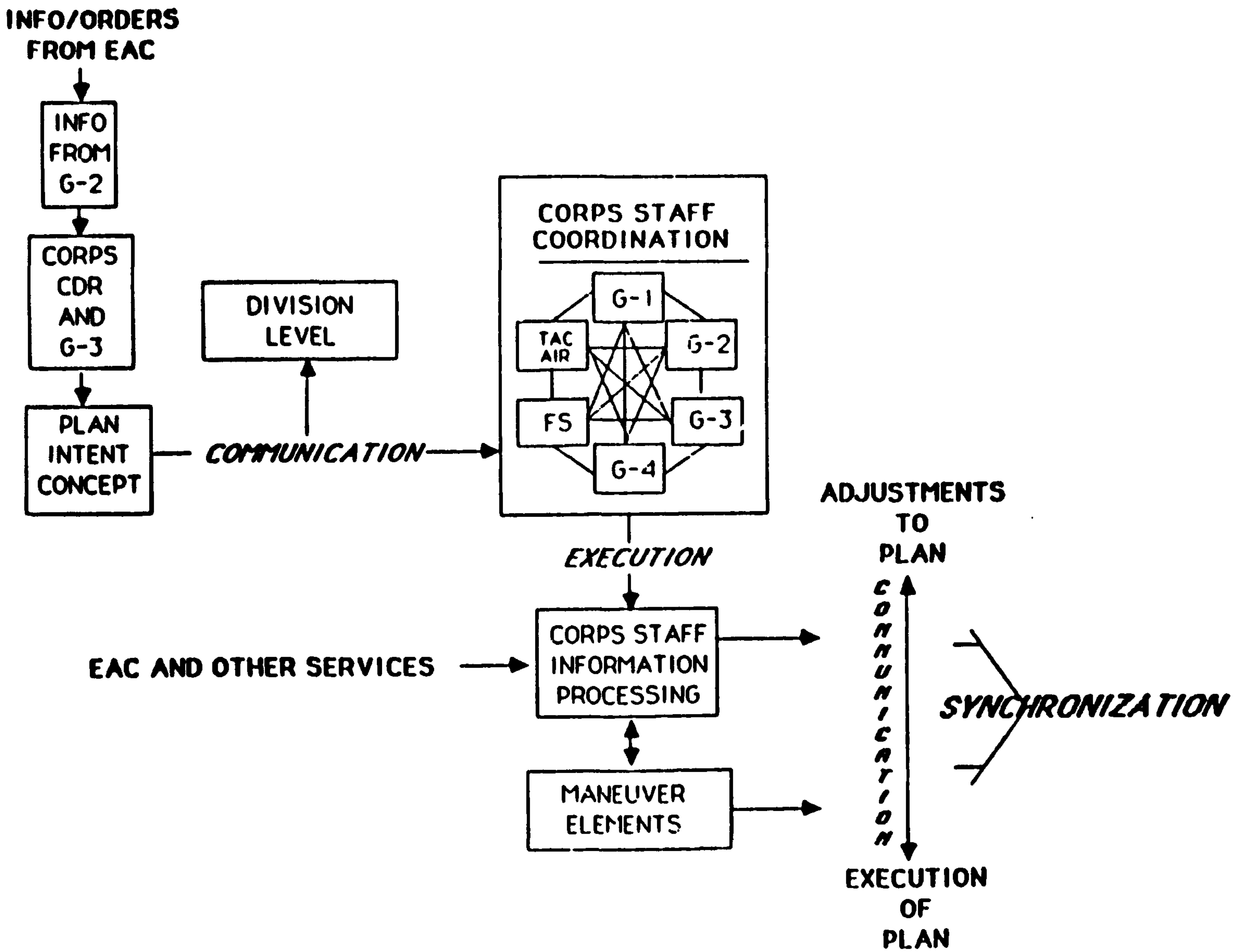



FIGURE 4-3. Corps Synchronization Performance Model

and the corps commander are the primary planners for the corps operation. These two individuals also share the greatest burden in communication of the the concept of the operation and the commander's intent to the division commanders and the corps staff. Once the operations begin, the corps staff essentially functions as an extension of the commander in communicating and executing his intent and concept of the operation. Once the execution phase is entered, the ability of the corps staff to gather and process information is the primary corps-level effect on synchronization of the operation. Subordinate units impact on synchronization through their success and failure in executing their respective missions outlined in the plan and subsequent orders provided by the corps commander and his principal staff.

In the model described above, synchronization is treated as a surrogate measure of combat performance. While the ultimate criteria of interest are combat outcome measures, as noted earlier, such criterion measures are "contaminated" by a variety of nested unit effects which are not clearly understood. As a result, the proposed measurement system will use measures of synchronization and direct measures of corps staff actions as performance indicators. As the measurement system is developed and data are collected, it will be possible to examine the relationships between these "proximal" criteria and the "distal" criterion of combat outcome.

The strategy of using measures of synchronization as a proximal outcome measure is not considered to be the optimal solution to the corps performance measurement problem. However, given the results of the review of AirLand Battle doctrine presented earlier and the findings from a review of existing literature on organizational performance measurement systems, it represents the most viable approach given the current state-of-the-art in performance measurement technology.

The review of the performance measurement literature indicates that an information processing model of corps performance is consistent with the models used in previous attempts to measure performance of commanders and their staffs. The review of existing measurement systems developed to assess performance of Army staffs provides evidence supporting the information processing approach adopted in the current effort. The review also identifies a number of problems which must be avoided in development of the current performance measurement system.

The performance measurement systems literature review focused on the FORGE research program (Olmstead, 1978), the Headquarters Effectiveness Assessment Tool (HEAT) methodology (HEAT Executive Summary, 1984), the NTC performance measurement research program (The Army Research Institute Plan for an NTC-Based Research Program, 1986), and combat modeling. A more detailed discussion of the literature review may be found at Appendix B. The review of the performance measurement literature and examination of each of the four measurement approaches listed above suggests several conclusions. First, there is evidence that information processing models of command and staff performance may be related to effective performance of combat units. Second, while information process measures may be important, process-oriented measurement systems tend to produce highly subjective data which are not outcome-oriented. Third, a performance measurement system resembling the outcome-oriented system under development for the NTC has more potential for acceptability and utility than a performance measurement system which is primarily process oriented.

Another lesson learned by the present authors from work conducted at the NTC is that simply having large amounts of objective data does not ensure that commanders and their staffs will receive effective feedback. In fact, work at the NTC indicates that an effective performance measurement system must be developed based on some model of unit performance rather than developed inductively by aggregating large amounts of unrelated data which have been collected simply because an instrumentation system made it feasible to collect.

The review of the performance measurement literature also suggests that some caution must be exercised in using combat outcome measures generated by combat models. This finding reinforces the warning voiced earlier concerning the use of bottom-line combat outcome measures as the primary criterion measure for assessing corps-level performance.

## The Corps Model of Performance Revisited

The review of the measurement approaches described in Appendix B suggests that the model of corps performance presented in Figure 4-3 represents a reasonable basis for identification of criterion measures and performance factors for the corps level. Examination of the model in Figure 4-3 suggests a number of potential factors which may impact on a corps performance as measured by its ability to conduct a synchronized combat operation. The factors include:

- The accuracy and completeness of the information used to develop the corps' operations plan
- The soundness, adequacy, etc. of the operations plan developed by the commander and the G-3
- The degree to which the plan and intent of the commander are clearly communicated and understood by subordinate commanders and the corps staff
- The degree to which the corps staff successfully accomplishes the analysis, synthesis, and communication of information required to develop and implement the plan
- The extent to which subordinate echelons (particularly the maneuver elements) accomplish their assigned missions
- The degree to which lateral and vertical communications are maintained during execution of the operation
- The ability of the commanders and staffs, particularly at upper levels (division and corps) to adjust the original plan in response to changes in the battle scenario
- Logistical support to maneuver elements

While the list above is not exhaustive, it does provide a number of key performance dimensions which should impact significantly on the ability of the corps to accomplish its assigned mission. These performance dimensions can be directly translated into measurement requirements which identify the type of performance data which must be collected to provide diagnostic feedback to the corps commander and his staff for training purposes. Table 4-1 lists the criterion data and performance dimension data categories which the review of doctrine and corps performance model suggest should be included in the corps performance measurement system.

| TABLE 4-1. DATA CATEGORIES | |
|---|---|
| CRITERION DATA | BATTLE OUTCOMES:<br>FRIENDLY CASUALTIES<br>FRIENDLY BATTLE DAMAGE ASSESSMENT (BDA)<br>OPFOR CASUALTIES<br>OPFOR BDA<br>TERRAIN GAINED/LOST<br>TIME FACTORS<br><br>LOGISTICS:<br>RESOURCES EXPENDED<br>RESOURCES DISTRIBUTED<br>ETC. |
| PERFORMANCE DATA | SYNCHRONIZATION MEASURES:<br>PLANNED EVENTS<br>ACTUAL EVENTS<br>PLANNED VS. ACTUAL TIME<br>PLANNED VS. ACTUAL LOCATION |
| INFORMATION PROCESSING | COMMUNICATIONS<br>TYPE INFORMATION PROCESSED<br>TIME TO PROCESS INFORMATION<br>SITUATION MAP VS. GROUND TRUTH<br>TIME TO DISSEMINATE INFORMATION |

The next section of the report presents a definition and discussion of the concept of synchronization. Synchronization is one of the underlying tenets of AirLand Battle doctrine and is the primary construct underlying the performance measurement concept developed in the current research effort. Following the discussion of the synchronization concept is a detailed description of the Inchon Landing Operation conducted during the Korean War. The Inchon Landing example is used to illustrate a means by which synchronization of operations may be illustrated graphically. The graphic representation of synchronization is one facet of the measurement development concept which will be presented in detail following the Inchon landing example.

## SECTION 5
## A MEASUREMENT CONCEPT FOR SYNCHONIZATION IN CORPS OPERATIONS

### Introduction

The complexity of a corps-level operation requires a performance measurement system to impose a certain degree of structure on the activities taking place during the operation. The concepts underlying the development of the measurement system are the primary source of this structure. This section of the report provides a working definition of the concept of synchronization in combat operations. The synchronization concept is the primary performance construct underlying the measurement concept described in the remainder of the report.

### Definition of Synchronization

FM 100-5, Operations (1986), defines synchronization as "the arrangement of battlefield activities in time, space and purpose to produce maximum relative combat power at the decisive point." (p. 17) It should be noted, however, that synchronization is a much more complex concept than that of massing fires on an objective. As noted in FM 100-5, synchronized activities may be "separate in time and space; however, these activities are synchronized if their combined consequences are felt at the decisive time and place." (p 17) For example, if actions taken to disrupt enemy suppl_ lines through deep attacks produce shortages of critical supplies at the time of a decisive engagement in the close battle, then the activities of the rear and close actions have had their desired synchronized effects.

The combined consequences of synchronized activities may produce tactical, logistical, and/or psychological effects. In fact, optimally synchronized actions such as the Inchon Landing engineered by General Douglas MacArthur during the Korean War are probably successful because the effects they produce on enemy forces are both psychological and physical in nature. For example, actions designed to produce shortages in enemy supplies are likely to be even more successful if they create the perception that forces near the FLOT are cut-off or surrounded. If the commander can time a major thrust at the FLOT with the arrival of information (or misinformation) in enemy intelligence channels that the units near the FLOT have been cut-off, the combined consequences of these activities will represent a synchronized operation.

While not stated as such, an underlying theme found in the many discussions of synchronization is that synchronized activities produce synergistic effects which are greater than the sum of the identical activities carried out in an unsynchronized manner. Such synergistic effects lie at the core of AirLand Battle doctrine as presented in FM 100-5. As noted in FM 100-5, to execute a synchronized operation a commander and his staff must construct and clearly communicate a detailed plan of the operation. The foundation for synchronized operations must be laid in the planning and preparation phases of the mission because positive command and control becomes extremely difficult once an operation enters the execution phase.

General William DePuy, USA retired, (1984) has suggested that synchronization is a complementary function which provides balance in a bold maneuver-based doctrine. DePuy uses the term synchronization to refer to horizontal coordination across functional control areas such as maneuver, fire control, and tactical air support. DePuy contrasts synchronization to the vertical functional control process across echelons. DePuy also contrasts synchronization and maneuver as being two methods for concentrating combat power -- maneuver is the method for concentration of forces in space while synchronization is the method for concentrating actions in time. In DePuy's conceptualization, synchronization is enhanced through detailed planning and clear communication of the commander's intent.

More recent use of the term synchronization encompasses the concept of concentration *in both the time and space* dimensions with coordinated maneuver considered as one aspect of synchronization. DePuy's model is important, however, in that it suggests that synchronization must be viewed as having both horizontal and vertical dimensions. The vertical dimension of "functional control" between echelons is most closely related to current definitions of command and control. The horizontal "synchronization" across functional areas represents staff integration at each echelon. DePuy's model suggests that each echelon represents an information synthesis node for horizontal coordination across functional areas while information flow between echelons must follow the chain of command within each functional area. If Figure 5-1 is viewed as an information flow matrix, DePuy suggests that information can flow only through horizontal and vertical pathways. An alternative proposition may be that thorough understanding of the commander's intent and efficient staff functioning should allow information flow along diagonal lines, i.e., across both functional areas and echelons simultaneously.

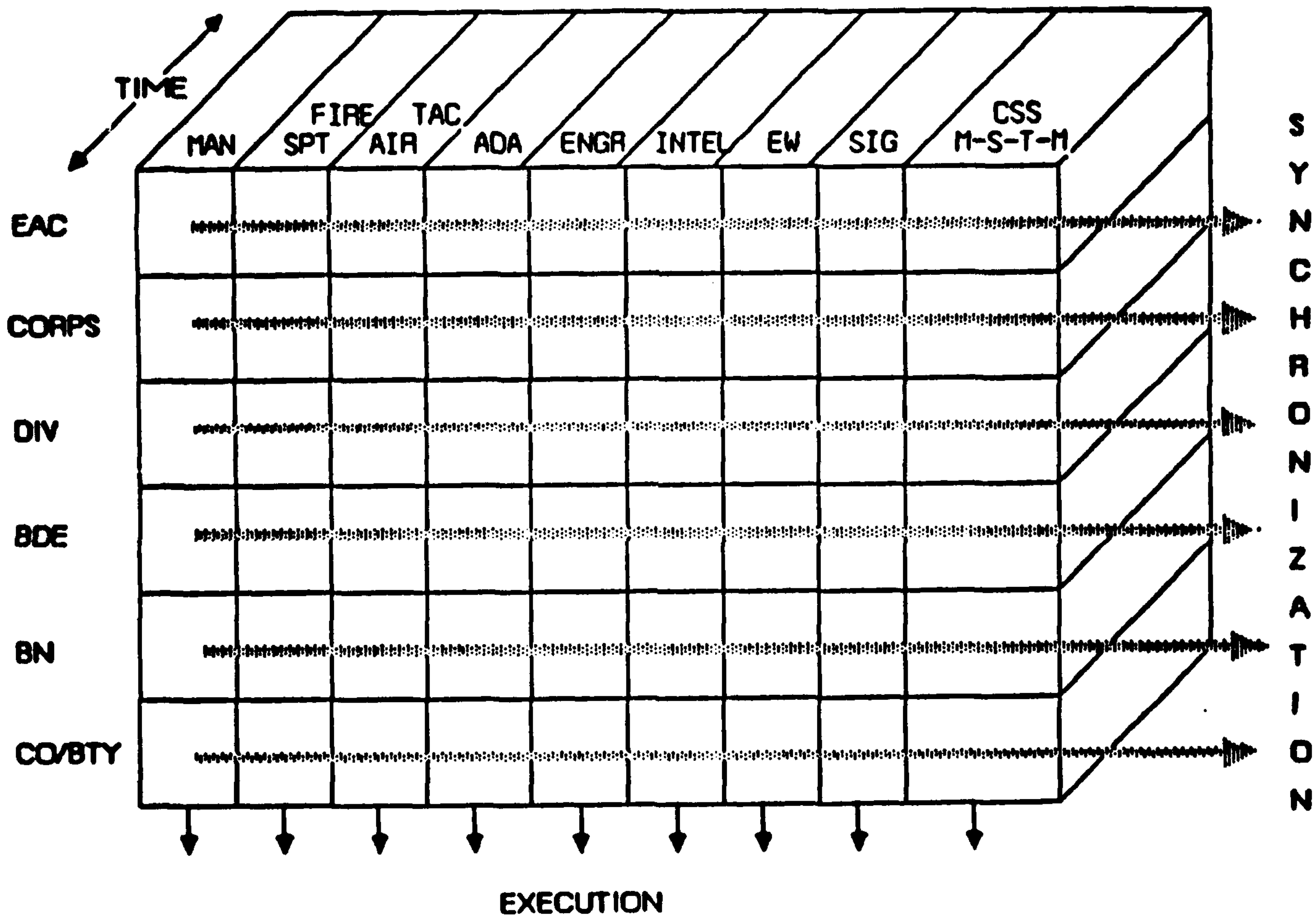



FIGURE 5-1. Horizontal, Vertical And Time Dimension Associated With Planning And Executing A Synchronized Operation

Such information flow patterns may be required to execute AirLand Battle doctrine and pass information upward in a timely manner. Perhaps, the existence of effective diagonal flows of information is one indicator of synchronization in staff processes.

While DePuy suggests detailed planning as the primary means of producing synchronized operations, he also notes that effective communication of the commander's intent is a critical factor. In an ideal sense, a synchronized operation is one in which the commander's intent is successfully operationalized on the battlefield. Whether or not such a synchronized operation leads to successful outcomes depends in part on the quality of the commander's concept of operation. A well synchronized operation may still result in failure if the commander's concept is based on inaccurate information or if unpredictable events such as enemy use of nuclear weapons occur. Furthermore, the ability of the units involved in the operation to adjust to unexpected events will also impact on success. Synchronization in the face of unexpected events on the battlefield requires complete understanding of the senior commander's intent as well as some minimum level of communications across both echelons and functional areas.

<u>Moving from the Abstract to the Concrete</u>

The definition of synchronization described above is a working definition based on concepts discussed in current military literature. To further clarify exactly what is meant by the term synchronization and to examine a potential means for measuring synchronization, the research team examined historical examples of synchronized operations. After a measurement concept for synchronization was developed, the concept was applied to the analysis of the Inchon Landing Operation conducted by General Douglas MacArthur during the Korean War.

The Inchon Landing analysis provides a concrete example of the synchronization concept. This example will be presented in the next section to illustrate how synchronization in an actual military operation can be illustrated graphically. Following the Inchon Landing example, the general performance measurement concept for assessing corps-level operations within a joint exercise context will be described in detail.

## SECTION 6
## APPLICATION OF A SYNCHRONIZATION MEASUREMENT CONCEPT TO THE INCHON LANDING OPERATION

### Introduction

One means by which the authors examined the viability of the synchronization measurement concept was to apply the concept to the Inchon Landing, a corps-level operation conducted during the Korean War. The purpose of the application was to examine the results of using the battlefield event timelines as a means of representing planned and actual events in a synchronized major operation. While the detailed operations plan from which the planned event timeline would normally be constructed was not available, it was possible to construct fairly detailed timelines of planned events based on available historical accounts of the Inchon Landing.

### Approach

General Douglas MacArthur's invasion of Inchon (Operation Chromite) was selected as the vehicle for exploring the application of the synchronization measurement concept for two reasons: 1) the degree of planning and precision involved, and 2) the operation demonstrated success in employing numerous combat elements at various echelons. As discussed previously, the measurement approach applied to the Inchon example was based largely on: 1) The FM 100-5 (1986) definition of synchronization (particularly elements of time, space and purpose) and 2) General William DePuy's (1984) view of military organizations as vertically and horizontally integrated functional systems. A review of Michael Langway's, Inchon: MacArthur's Last Triumph (1979) and other sources (Hoyt, 1984; Sheldon, 1968; Manchester, 1978) revealed that sufficient detail regarding time, space and purpose of many of the Inchon combat activities were available to conduct the analysis.

### Evolution of Operation Chromite

Before discussing the development of the Inchon Landing example, it is useful to place this ambitious assault in the proper context of the Korean War. The invasion of South Korea occurred on 25 June 1950, when North Korean tank forces crossed the 38th parallel (See map at Figure 6-1). At that time there was only a small advisory force of American troops in South Korea. The Korean Army itself was ill-prepared. Armed with the element of surprise, the North Korean People's Army (NKPA) made quick and strong advances and it was not until late July that any effective resistance

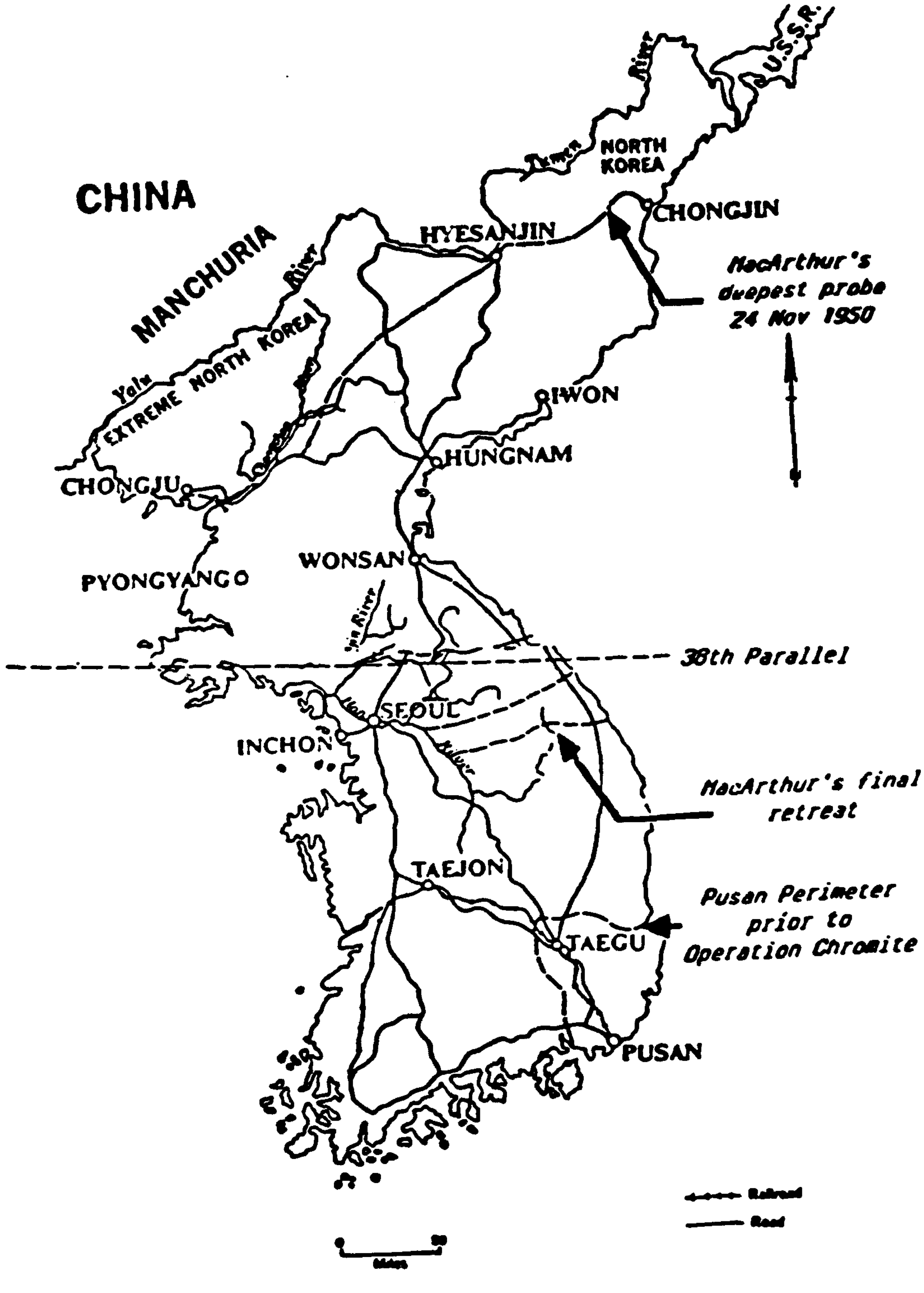



FIGURE 6-1. Fronts Prior To And After
Operation Chromite

could be mounted. Essentially, North Korean forces had overrun the country, being stopped just short of Pusan at the southern end of the peninsula by the Eighth Army recently re-established under authority of the United Nations. On 10 September, the NKPA advance was halted; however, NKPA deployment of an additional 98,000 men in 13 infantry divisions threatened to defeat the Eighth Army. Five days later General Douglas MacArthur initiated Operation Chromite with a joint force tailored to perform an amphibious assault on Inchon. In Reminiscences (1964) the general described his operation and his intent in the following cable sent to Washington on 23 July 1950:

> Operation planned mid-September is amphibious landing of a two division corps in rear of enemy lines for purpose of enveloping and destroying enemy forces in conjunction with attack from south by Eighth Army. I am firmly convinced that early and strong effort behind his front will sever his main lines of communication and enable us to deliver a decisive and crushing blow. The alternative is a frontal attack which can only result in a protracted and expensive campaign. (p. 346)

On 29 August 1950, MacArthur was notified by wire from the Joint Chiefs of Staff to begin preparations for the Inchon landing. Planning had already begun by early-August but, "The tide and the treacherous channel, blockaded by the island, gave MacArthur six weeks preparation and training in which thoroughly to familiarize his men with the curious habits of the influx, instead of the six months which such an operation would normally have demanded." (Langley, p. 20) While Operation Chromite was being planned in detail by General Almond of X Corps, the command structure (shown in Figure 6-2) was being assembled. MacArthur had continued to argue his case that the NKPA could not prepare to repel an assault in so short a period of time, if in fact the enemy even believed such an operation would be undertaken. He was later proven correct. When the Marines landed at Inchon on 15 September, the NKPA was caught by surprise by American troops who demonstrated a keen understanding of MacArthur's intent and concept for the Inchon Landing operation.

The Inchon invasion consisted of three distinct amphibious landings, the latter two occurring simultaneously. Each landing occurred on a separate beach, designated by one of the colors green, red or blue. A map of the Inchon area at Figure 6-3 shows the location of the invasion beaches. Preceding the operation, information was gathered by the Navy which detailed the landing conditions

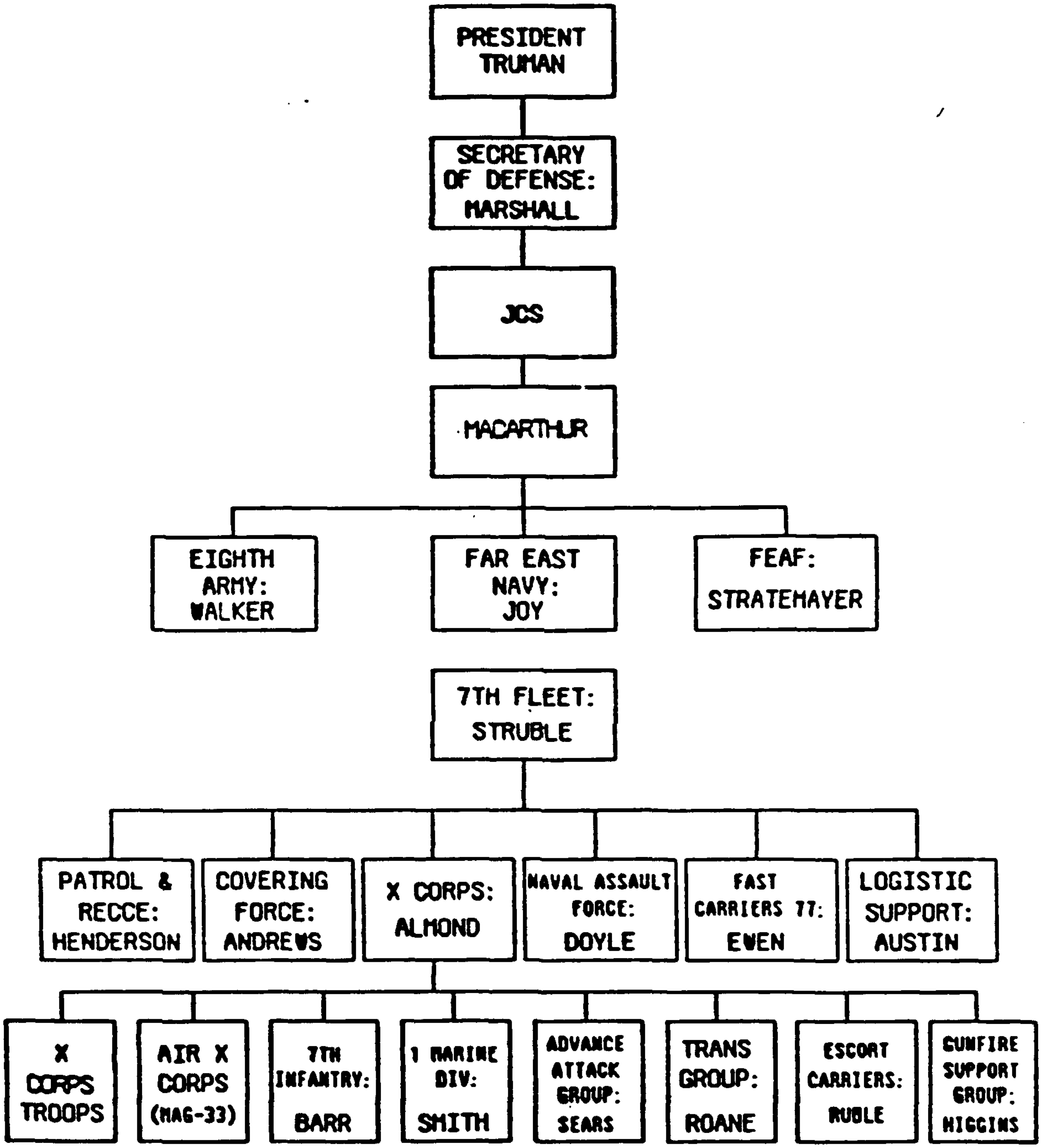



FIGURE 6-2. Command And Control Structure For Operation Chromite.

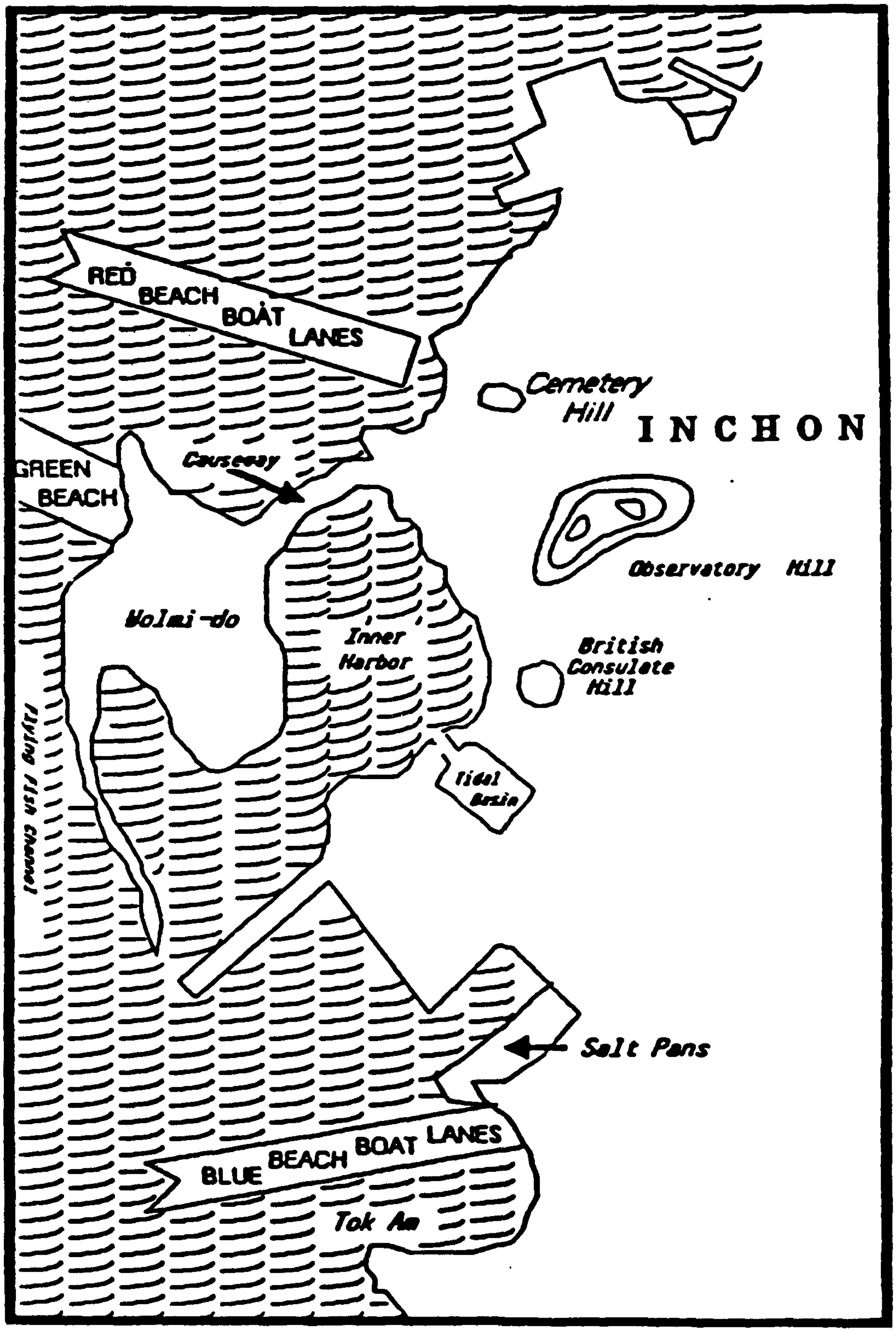



FIGURE 6-3. Invasion Beaches

the Marines would encounter, and provided some knowledge of the nature of the defenses at Inchon. Green Beach was the first to be assaulted at 0633 on 15 September; however, the actual landing was preceded by a series of intense naval and aerial bombardments over the course of several days that significantly softened NKPA defenses. When the 3rd Battalion of the 5th Marine Division went ashore at Green Beach they were met with light resistance. By 1215 they had gained full control of the beach.

Shortly before Green Beach was officially captured, U.S. aerial and naval bombardment of Red Beach was ordered, this time with the additional goal of sealing off the Inchon area. At 1430 British warships began shelling Blue Beach. Both remaining beaches were scheduled to be assaulted at 1730. The 1st and 2nd Battalion of the 5th Marine Division arrived on Red Beach three minutes late and experienced some difficulty getting all troops ashore. Nonetheless, Red Beach was secured at 2359, though more resistance had been encountered than at Green Beach.

Blue Beach operations, which began on time, were intended to secure the southern and only remaining approach route to the port. As with the other landings, Blue Beach was preceded by heavy shelling. Two beaches were assigned to the 2nd and 3rd Battalions of the 1st Marine Division respectively. The landing proceeded somewhat chaotically: some equipment and troops arrived at the wrong place; some troops arrived late; and, in the midst of this, a third impromptu beach was established. Fighting continued until shortly after midnight, when Blue Beach was finally secured. In all, 13,000 Marines had been put ashore that day; Inchon and its port access was under U.S. control; and Marine casualties were relatively light (21 killed, 174 wounded).

The result of Operation Chromite was the swift capture of Inchon, and subsequently, the capture of Seoul 13 days later. These events in turn prompted redeployment of NKPA resources and enabled the Eighth Army to break out from the Pusan perimeter. As forces from MacArthur's X Corps and the Eighth Army converged, the NKPA were caught in the middle and 125,000 prisoners were taken; the initiative had been captured by MacArthur and the U.N. forces. What MacArthur and the U.N. forces did not know was that a few Chinese units had begun advancing into North Korea shortly after receiving word of the Inchon invasion. By the end of 1950, the number of Chinese and NKPA forces had grown to 500,000 and ultimately they ended the advance of U.N. forces. MacArthur's recall by President Truman was to follow a few months later. These latter events, however, occurred well after the effects of Inchon had been felt.

## Methodology

As shown in Section 5, a hypothetical matrix was constructed (Figure 6-4) to depict the vertical, horizontal and time dimensions associated with planning and executing an operation. This is the first step in the development of the synchronization example. Each cell within the matrix represents a functional element within the military organization at a given point in time. The time, space, and purpose associated with each activity are initially established by the commander (CMDR) and/or his staff. They may be referenced in the commander's explanation of the operation (CMDR's intent) or included in the operation orders. The degree of synchronization achieved by the organization, including any adjustments required during the course of an operation, is then determined by (1) The degree of effective horizontal coordination over time, and (2) The ability of individual functional elements to perform assigned activities successfully, i.e., achieving the objective at the right place and time.

The second step in development of the synchronization example was to construct a timeline based upon the key dimensions of interest: horizontal coordination across functional area, and time. Composed of details from Operation Chromite, Green Beach landing, Figure 6-5 shows the actions of each functional element. Time and functional areas were selected as the abscissa and ordinate respectively to provide a more conventional timeline view of activities. The echelon dimension was collapsed, and only "high-level" activities associated with the pre-invasion were included (historical information available makes the breakout of echelons difficult at best). Additional information describing each activity is provided to the right of the matrix. The timeline highlights the fact that many of the critical activities of pre-invasion were concentrated in time, in the hours and even minutes, preceding the Marine landing. It also shows that maneuver, air defense artillery, and tactical air functional elements were all acting almost simultaneously during landing operations.

The third, and final step taken, was to represent graphically information about required synchronization in the Inchon landing across functional areas. For this example, it was assumed that the purpose of each activity and the interrelationships between activities could be inferred with reasonable accuracy from historical accounts of the operation. Each activity was then examined to determine if it was related to any other activity, i.e., could it directly influence another activity? The

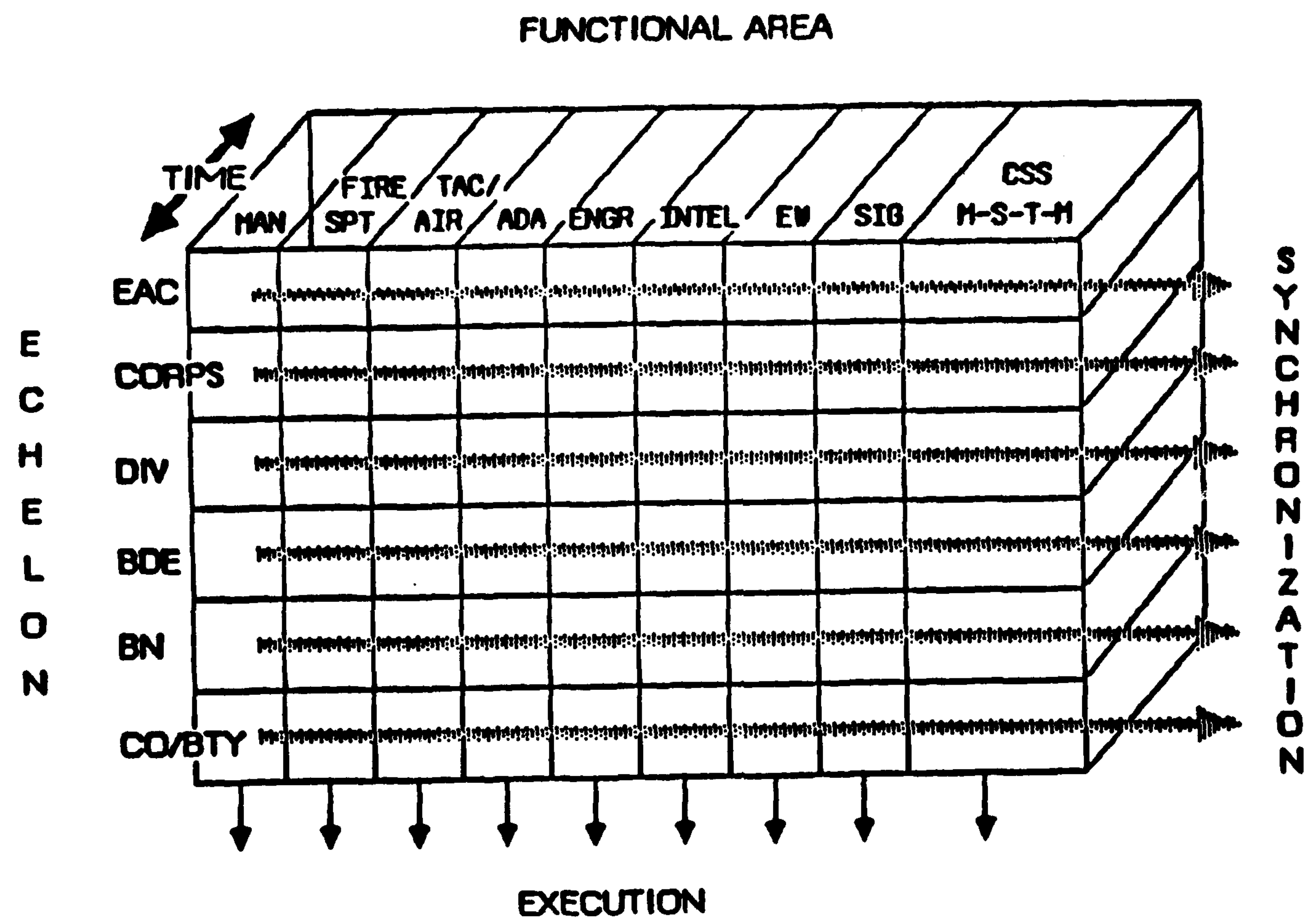



FIGURE 6-4. Horizontal, Vertical And Time Dimensions Associated With Planning And Executing A Synchronized Operation

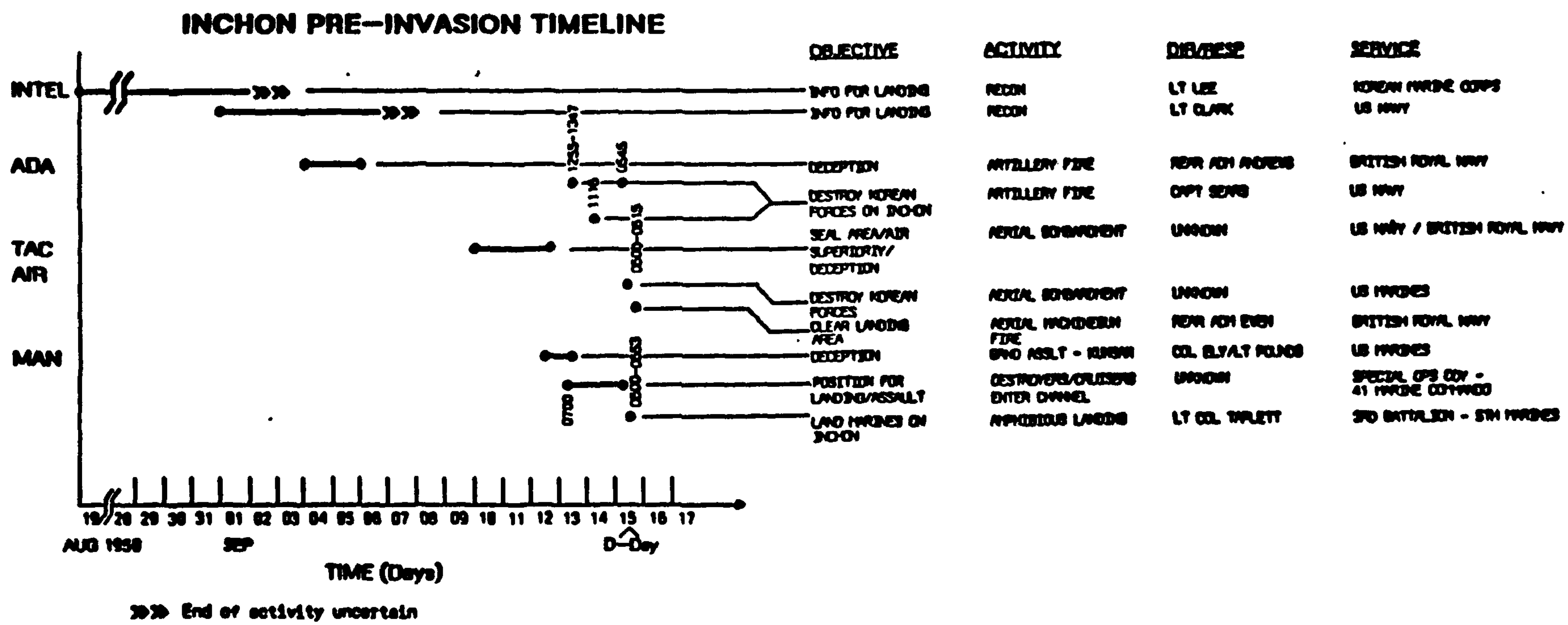



FIGURE 6-5. Inchon Pre-Invasion Timeline

interrelationships and coordination information were then added to the timeline, as shown in Figure 6-6.

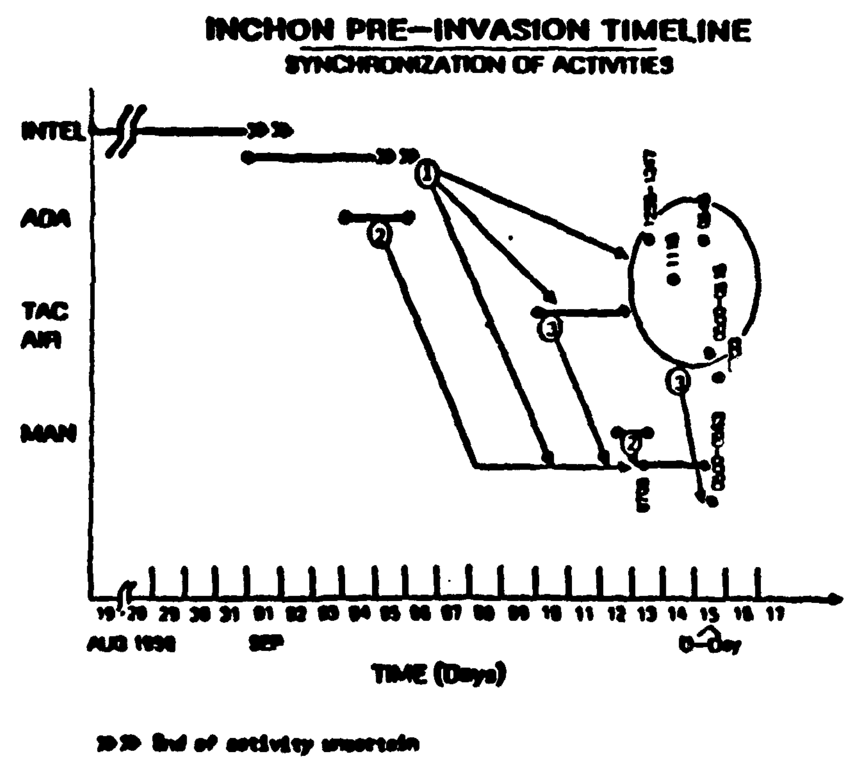
A summary of the type information developed for Figure 6-6 is as follows:

- A description of each interrelated activity or event
- A rationale for the interrelationship
- The relative degree of importance of each activity or event
- The desired effect
- The space and time relationship between each interrelated activity or event
- Critical time/space requirements (e.g. Aerial machine gun fire must commence immediately after landing and must cover area 50 yards in the front of Marines.)
- Required coordination between functional elements for each interrelated activity or event.

Multi-Echelon Synchronization

Examining the activities associated with the Green Beach invasion at Inchon demonstrated that synchronization could be expressed in terms of functional area event timelines. Time and event relationships on the battlefield that might typically be complex and difficult to visualize can be displayed graphically to enable clear presentation of the coordination required to successfully perform an operation. The success of this application of the measurement concept prompted the research team to further explore the application of the synchronization measurement concept to address the following desired capabilities:

- Compare planned operations to actual operations in a way that deviations from the plan can be shown;
- Illustrate the synchronization requirements of more than one echelon of command;
- Supplement the event timelines with graphics illustrating planned and actual unit locations.




| OBJECTIVE | ACTIVITY | DIR/RESP | SERVICE | COORDINATION |
|---|---|---|---|---|
| INFO FOR LANDING | RECON | LT LEE | KOREAN MARINE CORPS | USN - CLARK |
| INFO FOR LANDING | RECON | LT CLARK | US NAVY | KMC - LEE<br>USN - DOYLE |
| DECEPTION | ARTILLERY FIRE | REAR ADM ANDREWS | BRITISH ROYAL NAVY | 7TH FLEET - STRUBLE |
| DESTROY KOREAN FORCES ON INCHON | ARTILLERY FIRE | CAPT SEARS | US NAVY | 3RD BN/5TH MARINES -TAPLETT |
| SEAL AREA/AIR SUPERIORITY/ DECEPTION | AERIAL BOMBARDMENT | UNKNOWN | US NAVY/BRITISH ROYAL NAVY | TBD |
| DESTROY KOREAN FORCES | AERIAL BOMBARDMENT | UNKNOWN | US MARINES | |
| CLEAR LANDING AREA | AERIAL MACHINEGUN FIRE | UNKNOWN | BRITISH ROYAL NAVY | |
| DECEPTION | GRND ASSLT-KUNSAN | COL [illegible] POUNDS | US MARINES | |
| POSITION FOR LANDING/ASSAULT | DESTROYERS/CRUISERS ENTER CHANNEL | UNKNOWN | SPECIAL OPS COY/ 41 MARINE COMMANDO | |
| LAND MARINES ON INCHON | AMPHIBIOUS LANDING | LT COL TAPLETT | 3RD BATTALION/ 5TH MARINES | |

ACTIVITY INTERRELATIONSHIPS

1. Reconnaissance of conditions (height of seawall, tides, etc.) used to guide destroyers and cruisers into Flying Fish Channel. Information on defenses also useful for targeting. Completion required prior to start of entry to channel (Entry must occur by 15 Sep 1950.)

2. Deception activities precede landing operations and direct enemy attention away from Inchon. Timing does not appear to have been considered critical.

3. Marine and naval bombardment of Inchon first enables uncontested entry of U.S. ships to landing area, later neutralizes threat to marine landing and minimizes resistance. Timing of naval bombardment critical in the moments prior to landing.

FIGURE 6-6. Interrelationship Of Inchon Pre-Invasion Activities

To address these issues, Operation Chromite was revisited and the simultaneous invasions at Red and Blue Beaches were analyzed. Timelines depicting the plan of operations for both beaches were developed at corps and battalion level. Actual activities and events were then developed on a separate timeline for comparison. Finally, the use of maps was explored to depict planned and actual locations for individual units.

Corps-Level Operations

The complexity of the Red and Blue Beach (RBB) invasions was similar to that of Green Beach, described above; however, the number of activities and the amount of terrain was greater. Consequently, the first step taken was simply to catalog each activity planned and any other information available about the activity. This information is summarized in Table 6-1. Because the Red and Blue Beach invasions were scheduled to begin after the completion of the Green Beach invasion, it was important to determine if any of the units involved with the earlier assault would be included in the later assault. As could be expected, the fire support and tactical air elements were again assigned to bombard the invasion areas. In addition, an engineering team had been assigned responsibility for securing the Wolmi-do Causeway and troops at the northern end of Wolmi-do were expected to provide covering fire to the RBB assault force. The actual invasion force, the 3rd Battalion, 5th Marine Division, was not involved at Green Beach.

The first timeline constructed was intended to portray the RBB invasion as it was planned for each beach and as shown in Figure 6-7. As the timeline was being constructed it became apparent that most planned times for activities were not available. Actual times for activities, where available, were used instead. As shown, four functional areas were employed: engineering (ENGR), fire support (FS), tactical air (TAC AIR), and maneuver (MAN). The timeline shows that corps assets particularly in the FS and TAC AIR functional areas were not simply divided in two to assault the beaches independently, although some of these assets were dedicated to individual beaches.

Figure 6-7 also depicts the diversity of activities planned to occur prior to and during the landing of marine forces. Note that more activities were scheduled for Red Beach. Although the reason for this is not given in the historical reference material used, it is apparent from descriptions of the fighting on each beach that Red Beach

## TABLE 6-1. RED AND BLUE BEACH ACTIVITY SUMMARY

| REF | | BEACH | ORG/ ELEMENT | RESP | START | END | OBJECTIVE |
|---|---|---|---|---|---|---|---|
| 1 | Minesweep of Channels | Red | DeHaven | Capt Sears | 1200 15 SEP 50 | Unknown | Clear Boat Lanes for Lst approach |
| 2 | Clear Causeway | Red | ENGR Team | Tech Sgt Knox | Unknown | Unknown | Enable tanks to advance to mainland |
| 3 | Artillery Fire | All | Gunfire Support Grp | Rear Adm Higgins | 1200 15 SEP 50 | 1730 15 SEP 50 | Destroy/Disperse NCPA |
| 4a | Artillery Fire | Red | Toledo and Rochester | Rear Adm Doyle | 1430 15 DEP 50 | 1730 15 SEP 50 | Destroy/Disperse NCPA |
| 4b | Artillery Fire | Blue | Jamaica and Kenya | Rear Adm Ewen | 1430 15 SEP 50 | 1730 15 SEP 50 | Destroy/Disperse NCPA |
| 5 | Artillery Fire (Mil/ Ind Targets) | All | Dehaven and Swenson | Capt Sears | 1430 15 SEP 50 | Unknown | Destroy Enemy Facilities |
| 6a | Rocket Fire | Red | LSMR-403 | Cmdr Doss | 1704 15 SEP 50 | 1724 15 SEP 50 | Pin down/Destroy Enemy near Beach |
| 6b | Rocket Fire | Blue | LSMR-401 & LSMR-402 | Cmdr Doss | 1704 15 SEP 50 | 1724 15 SEP 50 | Pin down/Destroy Enemy near Beach |
| 7 | Aerial Bombardment | Red | Fast Carriers 77 | Rear Adm Ewen | 1200 15 SEP 50 | Unknown | Seal Invastion Area/ Disrupt NCPA movement |
| 8 | Aerial Reconaissance and Bombardment | All | Task Force 77 | Rear Adm Ewen | 1550 15 SEP 50 | Unknown | Prevent NCPA rein-forcement |
| 9a | Aerial Strafing | Red | Corsairs | Rear Adm Ewen | 1733 15 SEP 50 | Unknown | Clear In-coming path for Marines |
| 9b | Aerial Strafing | Blue | Corsairs | Rear Adm Ewen | 1733 15 SEP 50 | Unknown | Clear In-coming path for Marines |

TABLE 6-1. RED AND BLUE BEACH ACTIVITY SUMMARY, CONTINUED

| REF | ACTIVITY/EVENT | BEACH | ORG/ ELEMENT | RESP | START | END | OBJECTIVE |
|---|---|---|---|---|---|---|---|
| 10 | Covering fire from Green Beach | Red | 3rd BN 5th Marines | Lt Col Newton | 1730 15 SEP 50 | Unknown | Disrupt/Pin down Enemy |
| 11 | Red Beach Assault | Red | 5th Marine Regiment | Lt Col Murray | 1730 15 SEP 50 | 2359 15 SEP 50 | Seize area 3000 yds. long, 1000 yds deep from Cemetary Hill to Inner Tidal Basin and including Observatory Hill |
| 12 | Blue Beach Assualt | Blue | 1st Marine Regiment | Col Puller | 1730 15 SEP 50 | 0130 16 SEP 50 | Seize and Secure Beachhead covering Inchon proper and road to Yongdungpo and Seoul |

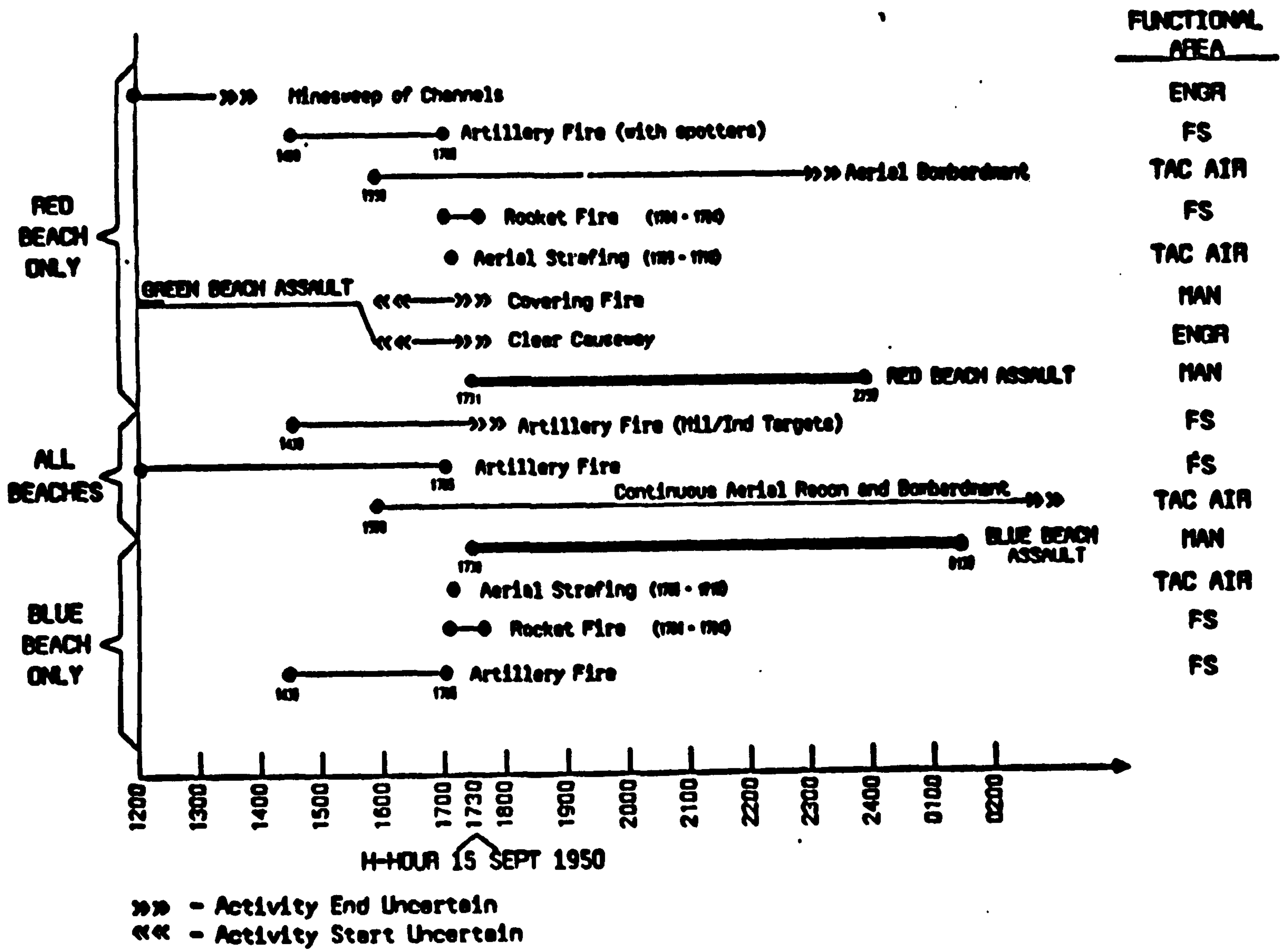



FIGURE 6-7. Red And Blue Beach Invasion Timeline: By Beach

was more heavily fortified by NKPA forces. Advance knowledge of this may have accounted for a larger scale assault on Red Beach.

Having identified the activities associated with each invasion and respective functional areas, activities were rearranged on the timeline so as to be arrayed by functional area (Figure 6-8). A new activity was added, landing craft vehicles and personnel (LCVPs) to Beach, at the beginning of each of the Red and Blue Beach Assaults. Some activities which were similar enough in time and in the same functional area were collapsed into one activity to make the timeline easier to read. The Activity/Event Reference, located on the right, references each activity in the Activity Summary presented in Table 6-1. This column also shows where activities were collapsed, e.g., 4a-b means two activities are being represented by Artillery Fire line. As was the case with the Green Beach operation, the Red and Blue Beach invasion had a great number of activities concentrated in the hours and minutes before the marines were landed. MacArthur reportedly had ordered that the success of Green Beach be evaluated before commencing any further invasion activities. The similarity between the invasion timelines reflects the success of the Green Beach operation, and MacArthur's desire to repeat that success.

The final step in depicting the Red and Blue Beach invasion plan was to show the degree of synchronization involved across functional areas. Figure 6-9 shows six key interrelationships which can be inferred between activities, five of which involve two functional areas.

A summary of the information developed for each interrelationship is provided below. Also of note is the degree to which the operation was keyed to the maneuver function. Every activity of the Red and Blue Beach invasion appears to have been in some way related to preparing for or facilitating the maneuver element's activities on the beach and further inland.

<u>Interrelationship 1</u> Minesweep of the channels must proceed the departure of the LCVPs to Red Beach. Minesweep completion and location are critical to assure the safe approach of the marines. Time is critical only insofar as the minesweeping activity must be completed by 1645. Coordination is not required unless the operation plan is changed.

<u>Interrelationship 2</u> Covering fire to Red Beach and aerial strafing of Red and Blue Beaches must precede the marine landing in order to pin down the NKPA and prevent

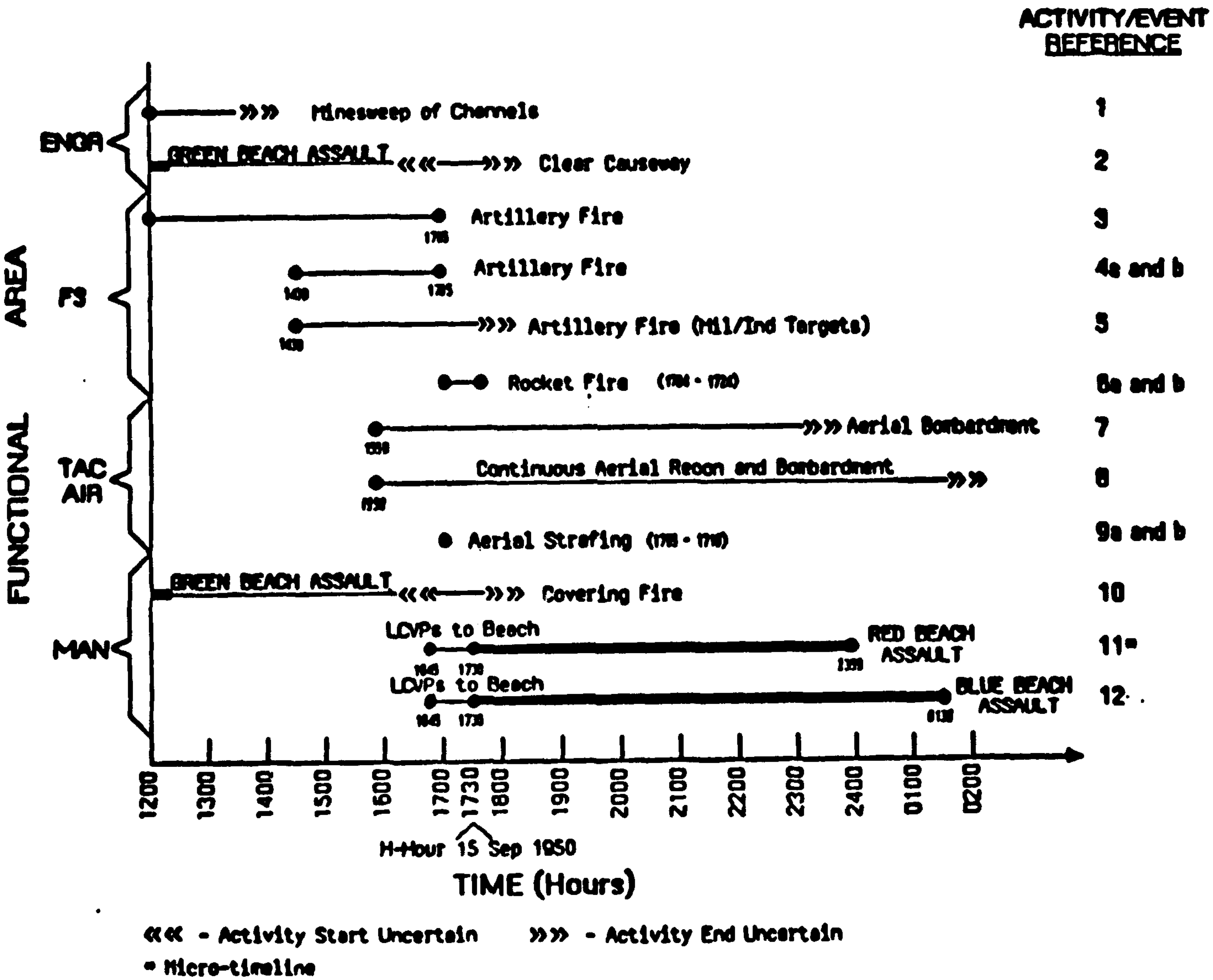
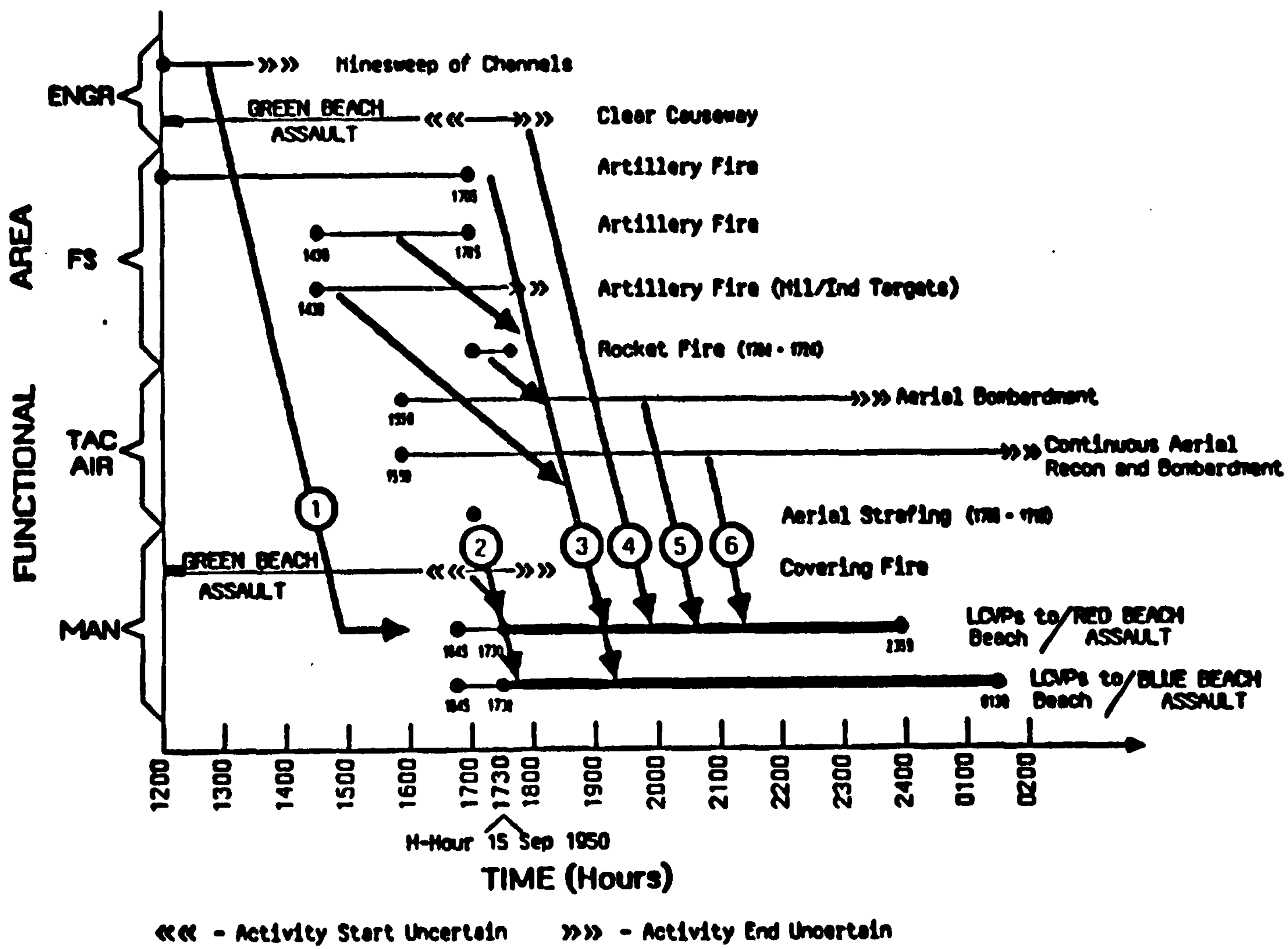



FIGURE 6-8. Red And Blue Beach Invasion Timeline: By Functional Area




«« - Activity Start Uncertain  »» - Activity End Uncertain

FIGURE 6-9. Red And Blue Beach Invasion Timeline: Activity Inter-relationships fire on the marines. Time and location are critical: both activities must commence immediately after the marine landing (1730) and must cover the area 50 yards in front of the landing force. Coordination may be required between the company commanders (Co Cmdr) and the Cmdr of the TAC AIR element.

Interrelationship 3 Artillery fire and rocket fire to Red and Blue Beaches prior to the marine landing is intended to lessen enemy resistance. Artillery fire time and location are not critical; it must be in the general Red and Blue Beach areas and must precede the landing force. Rocket fire time and location are important. It must commence immediately after cessation of artillery fire and end when the first wave of marines hit the seawall. Rocket fire should occur in the area near, but east of marines on the seawall. Coordination may be required between the Co Cmdrs and the Cmdr of the landing ships, medium (rocket) (LSMR).

Interrelationship 4 The Wolmi-do Causeway should be cleared of the enemy and obstacles prior to the Red Beach landing to enable elements of the 3rd Battalion (BN), 5th Marines to seal off Wolmi-do as an enemy retreat and later to provide covering fire to the advancing marines on Red Beach. Timing is not critical unless the causeway is not secured prior to the start of the Red Beach assault. Location is important; the entire causeway must be cleared. Coordination is not required.

Interrelationship 5 Aerial bombardment of Red and Blue Beaches prior to and during assaults are required to prevent enemy reinforcement and to disrupt local enemy movement. Location is situation dependent, and timing is not critical since the activity is planned to occur continuously before and during the marine assault. Coordination may be required between the BN Cmdrs and the Fast Carriers 77 Cmdr.

Interrelationship 6 Continuous aerial reconnaissance and bombardment of Red and Blue Beaches prior to and during assaults prevents enemy reinforcement and disrupts local enemy movement. Location is situation dependent and timing is not critical since the activity is planned to occur before and during the marine assault. Coordination may be required between BN Cmdrs and Task Force 77 Cmdr.

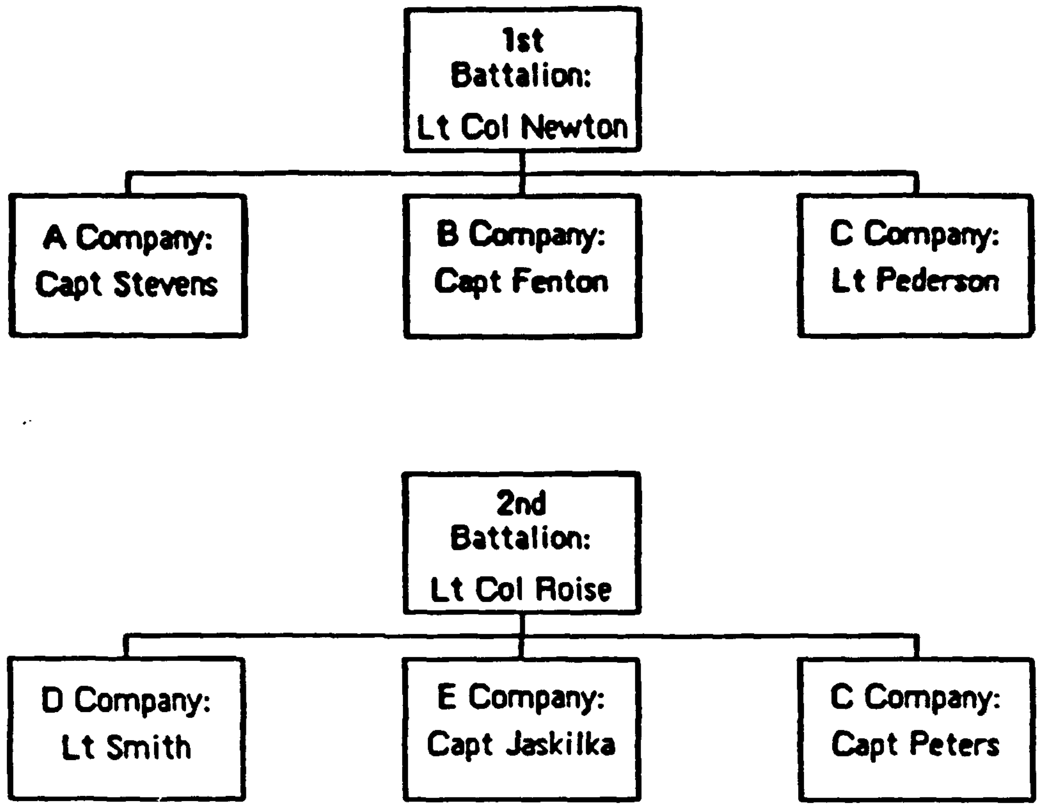
Comparing corps-level planned operations with actual execution of events proved to be somewhat difficult for Operation Chromite particularly due to the lack of available information on planned activity times which would normally be available in the corps and division operations plans. The lack of information may also be due in part to the flexibility built into the plan. For example, the only reported start time for any of the invasion activities was H-hour, the landing of the marine force. The start times for other activities were probably keyed to H-hour, though this is not known for certain. Also, activity end times appear to have been somewhat open-ended. These factors make it difficult to determine if any activities were not completed on time. Keeping in mind that Operation Chromite and in particular the Red and Blue Beach invasions were successful, suggests that deviations from the plan were minor and may only be found at lower echelons.

Battalion-Level Operations

Battalion-level operations were investigated in an attempt to identify events that did not go as planned during Operation Chromite, and to look at synchronization across a second echelon of command. The battalions responsible for the invasion of Red Beach were selected because Red Beach operations, though successful, did not go exactly as planned. There were delays and some subsequent difficulties with companies arriving at their assigned locations. The timelines and maps developed for battalion operations were designed to illustrate which activities did not go as planned, and where the deviations occurred in time and space.

The 5th Marine Regiment, 1st and 2nd Battalions, were assigned responsibility for seizing and securing Red Beach. The 3rd Battalion had already succeeded in taking Green Beach, and this area was secure when bombardment of the Red and Blue Beaches began. The organization and objectives of the six companies that invaded Red Beach are shown in Figure 6-10. The 1st Battalion was ordered to assault the northern area of the beach where resistance was expected primarily at the Asahi Brewery and at Cemetery Hill. The 1st Battalion was also expected to join flanks with 2nd Battalion to perform a joint assault on Observatory Hill. The 2nd Battalion was assigned the southern portion of Red Beach to include British Consulate Hill, Wolmi-do Causeway, the Tidal Basin, and the southern half of Observatory Hill (See map at Figure 6-11).

Invasion of Red Beach was scheduled for 1730 on 15 September 1950. The invasion force would arrive in waves, with A and E Companies leading. The remaining companies would follow, although their planned time of arrival is unknown. The operation was expected to commence with simultaneous assaults on Cemetery Hill and British Consulate Hill. The companies arriving in the second wave would then join forces to assault Observatory Hill, which was expected




| UNIT | OBJECTIVE |
|---|---|
| 1st Battalion | Seize and Secure area 3000 yards long, 1000 yards deep from Cemetery Hill to Inner Tidal Basin and including Observatory Hill. |
| A Company | Seize and Secure Cemetery Hill. |
| B Company | Seize and Secure No. half of Observatory Hill. |
| C Company | Seize and Secure Observatory Hill. |
| 2nd Battalion | Seize and Secure Southern area to include British Consulate Hill and So. half of Observatory Hill. |
| D Company | Dislodge and Capture enemy on Observatory Hill. |
| E Company | Sieze and Secure British Consulate Hill and So. Observatory Hill. |
| F Company | Secure Wolmi—do Causeway and Tidal Basin. |

FIGURE 6-10. Red Beach Organizations And Objectives

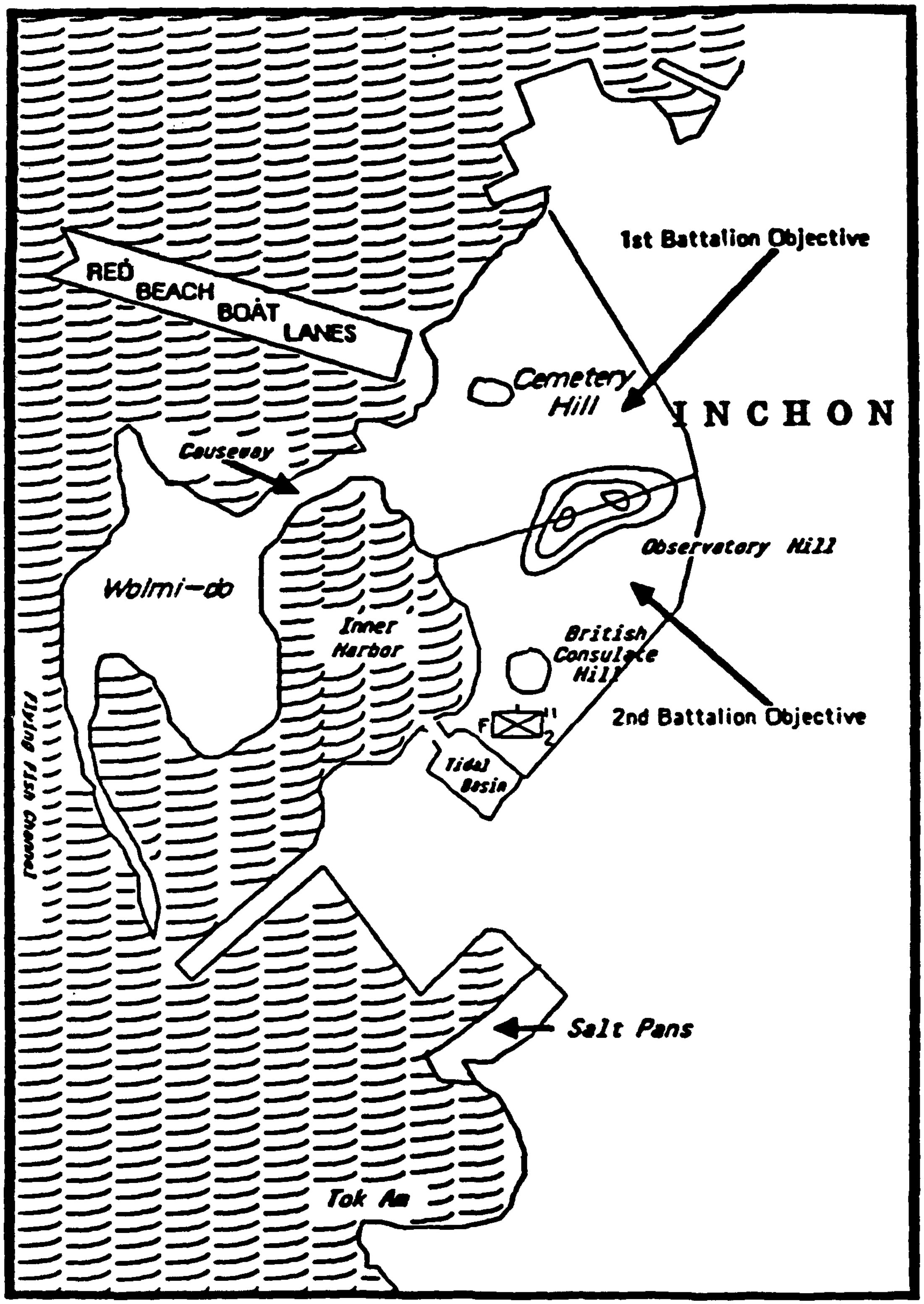



FIGURE 6-11. Red Beach Invasion Map: Planned

to produce some fierce fighting. Figure 6-12 shows the timeline of operations for each company and the interrelationships between company activities.

The first interrelationship is fairly straightforward. Obviously the timing and location of the LCVP approach is critical to the marine forces landing at the right place and right time. Interrelationship 2 depicts the requirement for Companies B, C, D, and E to close battalion flanks and make a coordinated attack on Observatory Hill. However, there are actually six time and location interrelationships between these activities:

1. B Company assault is related to C Company assault
2. B Company assault is related to D Company assault
3. B Company assault is related to E Company assault
4. C Company assault is related to D Company assault
5. C Company assault is related to E Company assault
6. D Company assault is related to E Company assault

From accounts of the operation, it is not clear if there was any provision for coordination between companies once the assault was under way. Considering the number of elements involved and the timing necessary to coordinate the attack on Observatory Hill, it would be very difficult to execute the attack as planned should any of the individual elements fail to arrive at the right place and time. This later proved to be a problem.

The first problem occurred when the 1st and 3rd Platoons of A Company were delayed at the Red Beach seawall because they found themselves pinned down by enemy fire. Also, one of the landing craft vehicles and personnel got hung up just off the seawall when it had engine failure. These delays did not disrupt operations significantly, as 2nd Platoon was able to move out from the seawall and quickly assaulted and secured Cemetery Hill. E Company, also in the first wave, did not encounter any delays and was able to move out as a unit and secure British Consulate Hill. The second wave of marines did not have the same luck. The commander of C Company, Lt Pederson, and his troops were diverted to assist the helpless LCVP. As a consequence parts of C Company were deposited at the wrong area at the wrong time. D Company also experienced similar problems at landing which meant that two of the three companies assigned to take Observatory Hill were in a somewhat confused state shortly after their arrival at Red Beach.

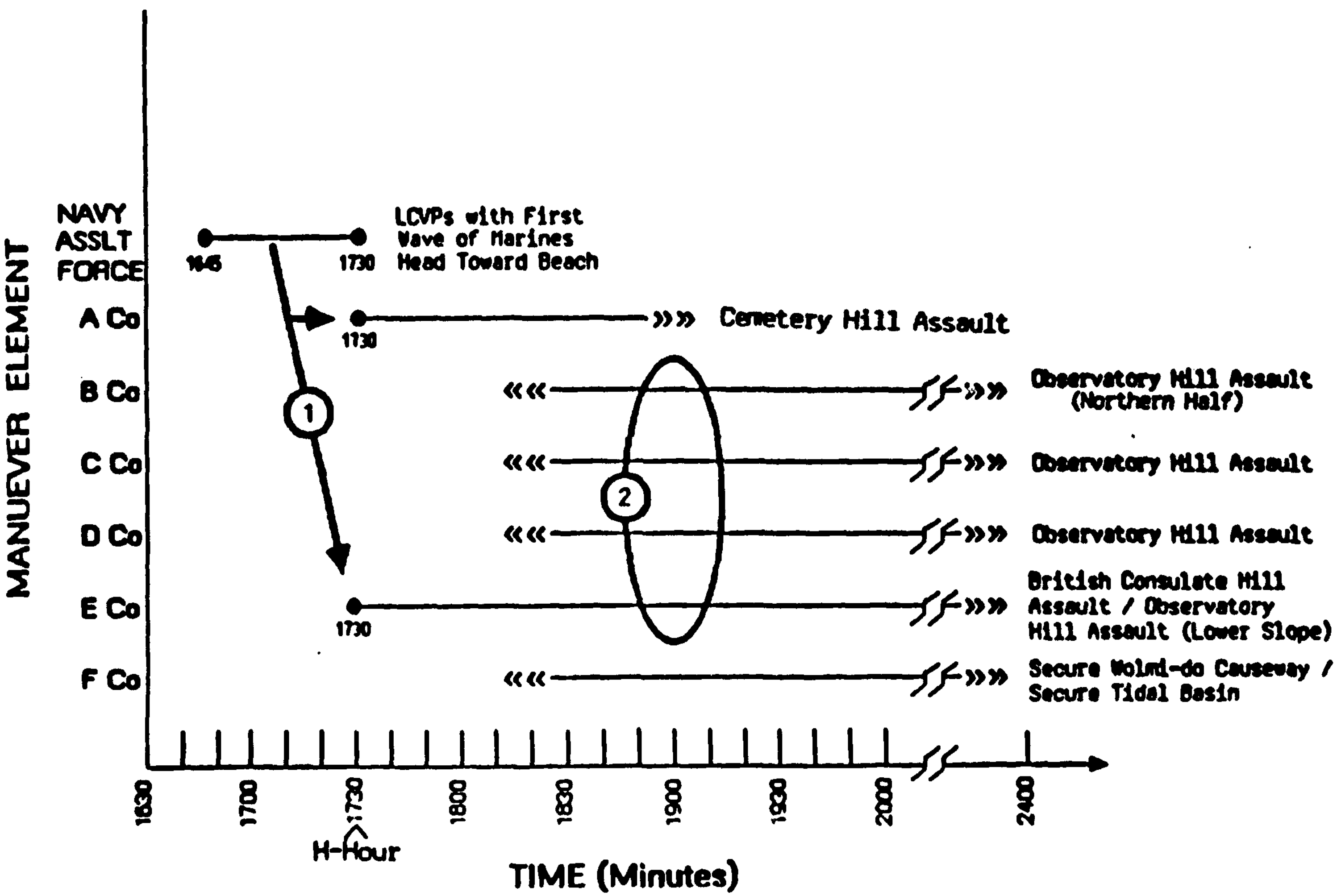



FIGURE 6-12. Red Beach Activity Timeline And Interrelationships

Once all the companies had arrived, more changes to the planned assault occurred. Because members of C and D Companies had difficulty finding and joining their respective platoons, the 1st and 2nd Battalions could not properly join flanks prior to approaching Observatory Hill. Their assault was not proceeding well and F Company was re-assigned to Observatory Hill to provide some additional firepower. This proved to be effective in completing the immediate objective, but did not enable the Causeway or Tidal Basin to be secured. For unexplained reasons, some landing ship, tanks (LSTs) were started up on the beach about the same time C and D Companies were experiencing difficulties. The movement was apparently intended to draw fire from the NKPA forces on Observatory Hill in order to give away their location. The maneuver worked, but the LSTs did not stop at this point. They then returned fire on the enemy, but also directed fire at Cemetery Hill and other apparently randomly selected targets. The other result of this maneuver was the loss of 1 marine and 23 others wounded. The Red Beach invasion timeline, as these activities actually occurred, is shown in Figure 6-13. Figure 6-14 shows the deviation in location of F Company as a result of their re-assignment to Observatory Hill. Also shown are the planned and actual locations for the 1st Battalion, 1st Regiment assigned to the Blue Beach invasion. When luck is mentioned with regard to MacArthur's operation, these two units and their successes may be considered a part of that luck. When F Company vacated the tidal basin area, they left the right flank of the 2nd Battalion exposed. During the Blue Beach landing, however, the 1st Battalion, 1st Regiment was mistakenly taken to the area southwest of the tidal basin. They should have landed 2 miles farther south. The 1st Battalion was a reserve force during the Blue Beach assault, and consequently their absence was not immediately problematic. When they arrived at the tidal basin area the battalion commander quickly evaluated the situation and was able to secure the area before moving south to join the Blue Beach forces. The result was that all objectives were taken.

## Conclusions

The graphic representations of the Inchon landing provide evidence that synchronization in an operation can be expressed in terms of functional areas and time. A timeline of activities and events can be used to construct a model which provides a picture of how an operation unfolded. The information in the timeline is particularly useful in summarizing key battlefield events and interrelated activities. A similar timeline, depicting planned activities and events provides comparative information to

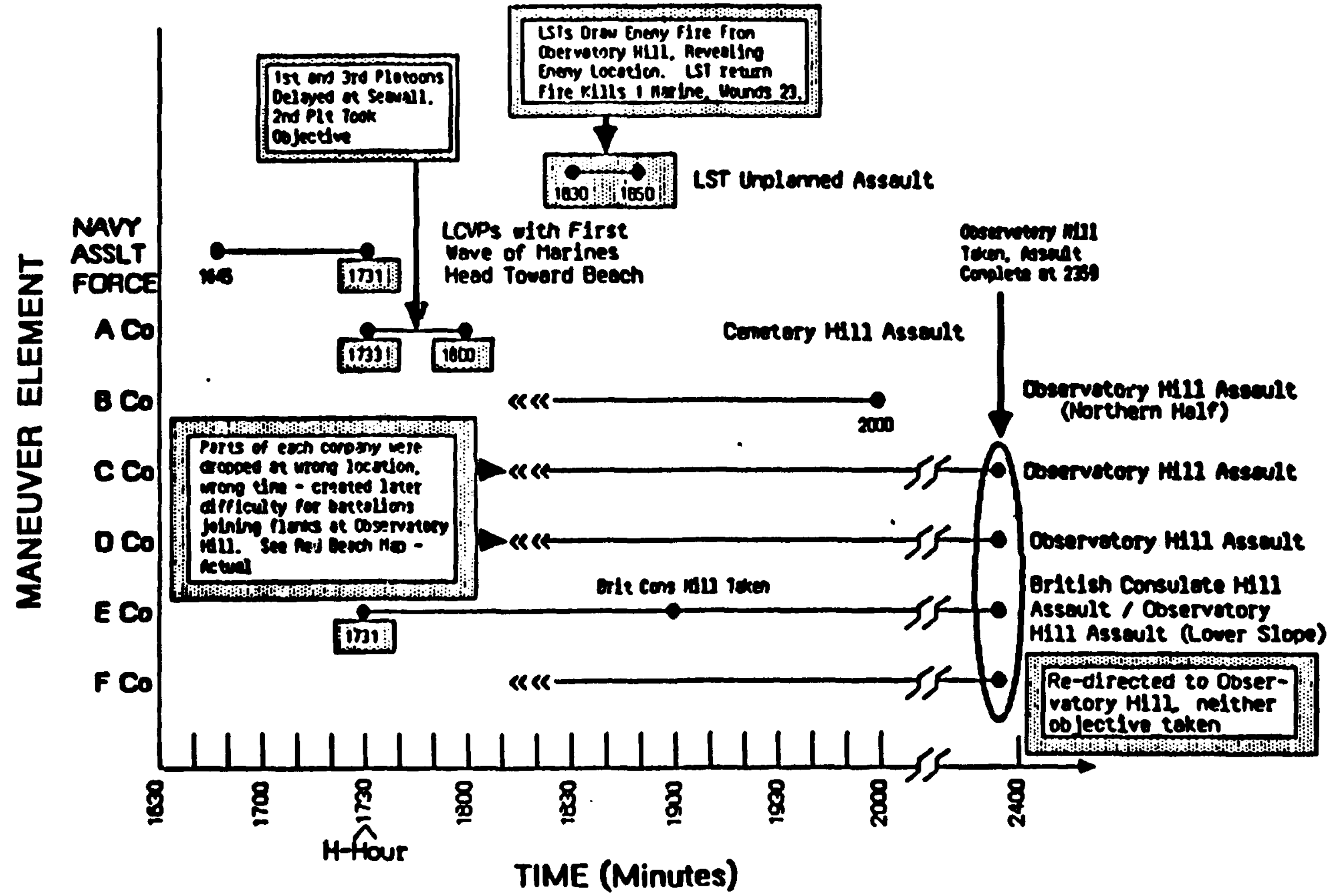



Figure 6-13. Red Beach Invasion Timeline: Actual

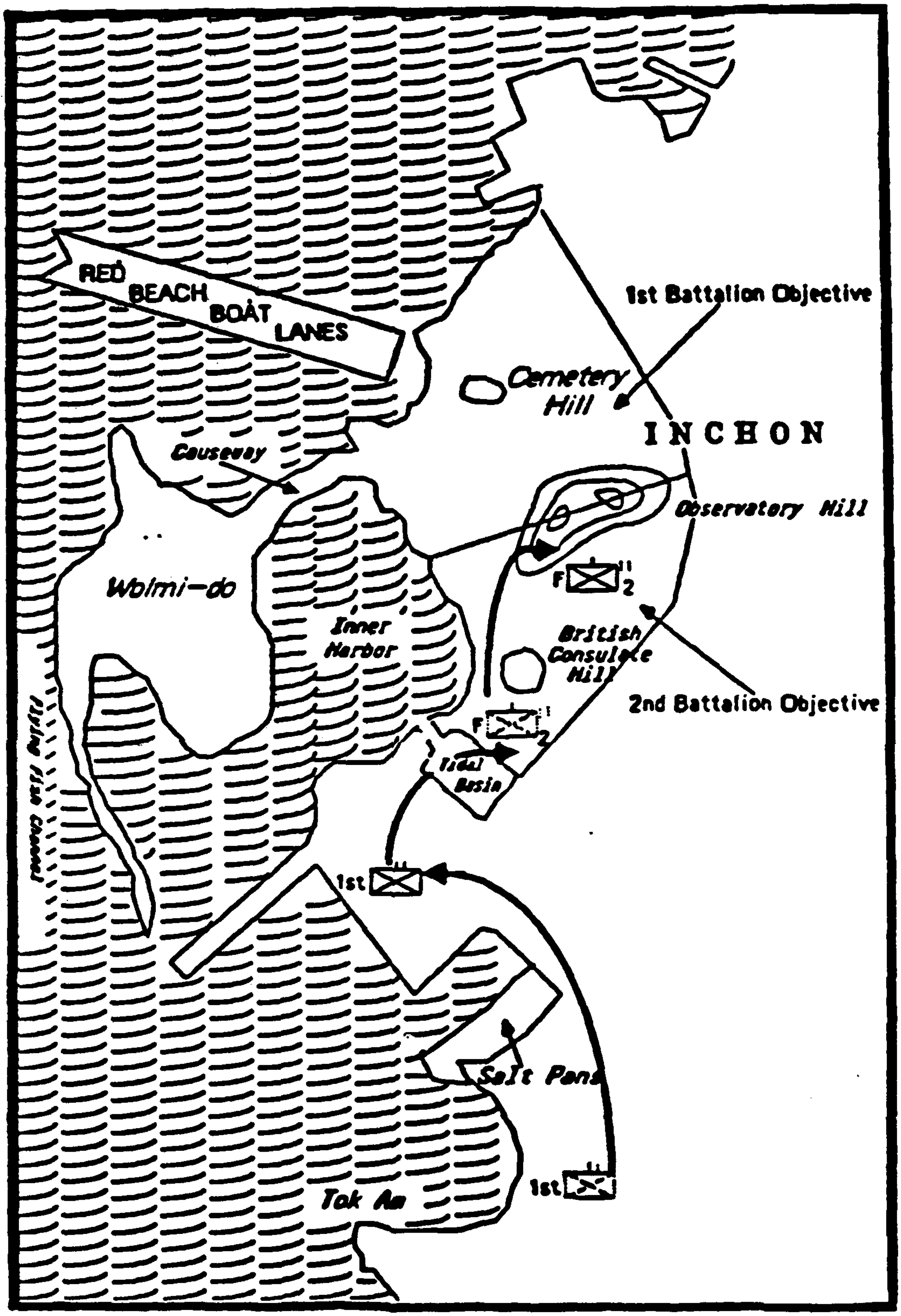



FIGURE 6-14. Red Beach Invasion Map: Planned And Actual Locations Of F Company 1st Battalion

identify where an operation deviated from its plan. When presented as part of an after-action review following an exercise, these timelines will enable a commander and his staff to quickly see which elements of the force were able to execute on time and which elements had problems meeting the timetable.

Functional areas in which problems in execution were demonstrated can be examined in greater detail by generating micro-timelines to summarize the activities of each functional area. The Red Beach example demonstrated the use of such multi-echelon timelines and situation maps. The Red Beach example also demonstrated that both time and space are important dimensions in achieving synchronized operations. In the case of C and D Companies' late arrivals, the two dimensions were seen to interact (e.g. the late arrival of C Company prevented them from massing at the appropriate location). Unplanned activities such as the LST maneuver can be shown and in fact could be related to later positive or negative battle activities and outcomes, activity or group of activities.

The application of the timelines to the Inchon Landing example confirmed that the graphic representation of information describing the interrelatedness of battlefield activities and events shows promise for use in developing measures of synchronization. For example, when a timeline of interrelated activities across functional areas is constructed, as was done for the Green, Red, and Blue Beach landings, one has taken the first step in identifying how those activities must be coordinated among functional elements. This is an essential element in a corps-level performance measurement system since the information from the timelines can be used to indicate where particular staff actions must occur at key points in time. Again, micro-timelines at various echelons will also provide the structure to track such things as: interfaces between functional elements and echelons; the objective of each activity; and the precision of execution in time and space. The timeline can also be used as an audit trail to identify activities that did or did not occur according to plan, and as a vehicle for developing feedback to the commander and his staff. Parallel timelines which relate staff activities over time to battlefield events, are additional tools to be used in providing feedback data to the commander.

Collectively, the tools described above represent a potential structure for development of measures of corps performance. The time dimension and specification of discrete events and linkages between functional areas at particular points in time provide the starting points for development of quantitative measures of synchronization. As will be discussed in sections 7 and 8, such measures might include variables such as frequency counts of the number of cross-functional connections required and/or achieved in an operation or the average deviation between the time an event was planned and when it was actually executed.

The application of the synchronization measurement concept to the Inchon Landing provides support for the viability and utility of the measurement concept. It should be recognized, however, that the information available for applying the measurement concept was extremely limited. The measurement of corps performance will require the collection of a variety of performance measures in addition to the development of the timelines illustrated in the Inchon Landing example. Section 7 outlines the structure of the entire corps performance measurement concept and Section 8 will then describe the data collection required to implement such a performance measurement system.

# SECTION 7
# THE PERFORMANCE MEASUREMENT CONCEPT

## Introduction

The battlefield event timelines used in the discussion of the Inchon Landing Operation in the previous section, represent specific examples of a measurement tool which can be used to begin to quantify the construct of synchronization in terms of discrete events and time. While the events and time scales must necessarily change from one corps operation to the next, the general structure of the timelines will remain the same. The performance measurement concept described in this section of the resort represents a more comprehensive set of measurement tools which may be used across a number of different exercises to assess the performance of Army corps.

## The Measurement Challenge

The development a set of highly specific measurement instruments for use in all corps level operations is probably impossible. At the division and corps levels, operations are extremely complex and the principle of equifinality applies, i.e. there are multiple ways to achieve any given outcome or objective. Thus, a measurement approach based on specification of mission specific tasks or functions to measure synchronization has little probability of succeeding. As illustrated in the Inchon Landing example, the operational definition of synchronization may only be achieved within the context of a particular military operation or exercise. On the other hand, a measurement strategy, structure of the measurement process, and methodology for development of operational definitions of synchronization can be constructed for application within the context of any corps-level operation.

In this section of the report, the authors will present a general measurement strategy and the basic structure of a measurement system for generating corps-level performance measures within the context of joint operations exercises conducted by the US Readiness Command (REDCOM) using the Joint Exercise Support System (JESS) and the Joint Theater Level Simulation (JTLS) as exercise drivers. Section 8 will present a detailed discussion of the data collection plan for operationalizing the Measurement system within the REDCOM context. Those readers unfamiliar with the joint exercise program conducted by REDCOM should review the description of the exercise process and the major components of the exercise system presented in Appendix C.

## Measurement Strategy

The measurement strategy adopted for development of corps level measure's of performance is concept-based rather than data-driven. This means that the starting point for the development of the measurement methodology was the identification of a performance construct or concept rather than a delineation of data which might be obtained in the context of the REDCOM simulation as it currently exists. The concept-based measurement development process ultimately requires the development of measurement procedures to capture data within a particular context. However, it provides a general measurement framework which can be applied across a variety of situations. The concept-based measurement strategy is also less likely to result in the development of procedure-oriented task, condition, and standard measurement instruments. Such "task checklists" are usually developed as a result of a job analytic approach to performance measurement that focuses on identification of observable behaviors which occur during performance of tasks associated with particular organizational objectives. Such bottom-up approaches may be appropriate at the small unit level for the development of performance measures in fairly standardized battle drills and/or routine staff procedures. They are not, however, appropriate for application to the operation of complex organizations such as found at the corps and EAC levels.

The concept which forms the basis for the measurement strategy adopted in the current effort is, obviously, the concept of synchronization. A legitimate question which must be addressed is why synchronization? A major pitfall in the use of a concept-based measurement strategy is that it may easily become a conceptual measurement strategy which is not reality-based. That is, the researcher may develop a measurement strategy which is derived directly from a particular organizational or information processing model. The measurement procedures developed in this situation are likely to have meaning to researchers familiar with the theory or conceptual model, but may provide data which are of little value to the military audience for which the measurement system is designed.

If, on the other hand, the concept driving the development of the measurement system is drawn directly from relevant military doctrine, the system is likely to provide meaningful feedback to the military audience -- assuming of course that the concept is operationally defined in terms of accurate and meaningful measurement procedures. The concept of synchronization is one of the four tenets which underlie basic AirLand Battle doctrine as presented in FM 100-5.

Synchronization is perhaps the least well defined and most frequently discussed of the tenets underlying AirLand Battle doctrine. The frequency with which synchronization is discussed in articles appearing in professional military journals such as Military Review reflects both the recognition of the importance of the concept and the complexity and difficulties surrounding its understanding. Thus, any progress made in the current research effort which aids in operationally defining synchronization will represent a major contribution to the literature.

A second reason for selecting synchronization as the concept driving the development of corps level measures of performance is that synchronization is perhaps the most relevant of the four AirLand Battle tenets for corps level operations. In effect, the decision has been made to define corps level performance primarily in terms of the performance of the corps commander and his staff. As noted earlier in the discussion of nested unit effects, it is extremely difficult to use bottom-line combat outcomes to represent "corps level" performance since they also represent the performance of all units between the corps and squad or team levels.

The review of AirLand Battle doctrine regarding operational levels of war and examination of various documents related to corps organizations and corps staff functions suggests that the critical role played by the corps is that of tactical battle management. Echelons above corps also have operational roles but often are more concerned with strategic implications of actions rather than management of the tactical aspects of the battle. The echelons below corps represent maneuver elements which function almost entirely at the tactical level. While commanders and staffs at the division level and below must manage battle assets, they are primarily fighting the battle rather than managing the battle. One might, in fact, suggest that the primary mission of the corps is to synchronize the operations at division level and below and to provide the primary focal point for synchronization of joint operations between ground, air, and naval forces.

Another aspect of the measurement strategy adopted in the current effort is that it will be based on the use of a probe methodology. A probe is a designated event or sequence of events which should stimulate the occurrence of a particular set of actions or behaviors. These behaviors or actions are designated as targets on which observers focus their attention after the probe has been implemented during the exercise or simulation. This methodology is a an essential part of the measurement strategy. Without the use of probes, the task of the observers or data collectors is unmanageable within an exercise as complex as those conducted at the corps level.

The authors recognize that the use of a concept-based measurement strategy also imposes certain limitations. By focusing on the construct of synchronization, other performance factors such as the commander's conceptual frame of reference will receive less attention in terms of measurement. As will be seen later in this section, however, numerous types of data will be generated as part of the performance measurement system.

Structure of the Measurement Process

The basic structure of the measurement process developed in the current research effort will be determined by a number of factors including:

- The purpose or objective of the measurement system (training)

- The performance concept to be operationalized (synchronization)

- The level of the organization being assessed (corps)

- The general context in which the performance measurement will occur (corps level simulation exercises)

- The available data collection technology (computer simulation data, video-tapes, observations)

As noted earlier, the primary purpose for developing the performance measurement system in the current research effort is to provide training feedback to corps commanders and their staffs. The general context, level of the organization, and synchronization concept have all been discussed previously. As noted above, the strategy used in the current measurement development process is concept-based rather than data driven. To remain reality-based, however, the structure of the performance measurement system must reflect the range of data collection technologies which are available. In the current effort, it is assumed that essentially four types of data gathered through three technologies are available. First, battle outcomes and a limited amount of battlefield action/event data can be obtained directly from the data stored in the memory of the computer simulation used as the exercise driver by REDCOM. Second, records of player actions, orders, etc., can be obtained through the use of videotapes and records made by observers. Finally, observations of critical information processing behaviors and the tracking of noncomputerized documents/products, etc. can be observed/inferred and recorded by observers.

Using a broadly defined concept of synchronization as the starting point and assuming a REDCOM exercise context as the site of implementation of the measurement system, a basic structure for the measurement system is outlined below. It should be stressed that this basic structure is tentative in nature and may be modified significantly after its feasibility is assessed through observations at a REDCOM exercise.

At the core of the measurement system will be a structural model of corps actions and information flow. The model will be three dimensional with a vertical dimension representing echelons (EAC through Brigade level) and a horizontal dimension representing critical functional areas to include Air Force and Naval elements. The third dimension, (depth) represents the time dimension. This matrix is illustrated in Figure 6-4 in Section 6. Different cells within the three-dimensional matrix will be representative of particular staff and command elements which are considered to be critical players in the corps operation. Some cells at various echelons may be empty cells. Moving through the time dimension, the cells will (represent the different staff and command elements at various stages or phases of the operation. The time dimension will begin at the start of the planning for an operation and end with the conclusion of the operation. Thus, the time dimension for a REDCOM operation may begin several days, weeks or even months prior to the time when the simulation driver model (JESS) is initialized and the exercise "begins".

The three-dimensional matrix described above represents the cornerstone of the measurement structure. The matrix provides the conceptual basis for the development of the battlefield and staff action event timelines described in the Inchon Landing example. The various components of the measurement system are designed to provide data required to construct a series of such event timelines which, when combined with other data, can be analyzed and synthesized to develop a description of corps performance. Before describing the various components of the measurement system, it will be beneficial to present an overview of the measurement process.

Overview of the Measurement Process

The corps performance measurement process is illustrated graphically in Figure 7-1. The process will begin with an analysis of the EAC operations plan. From this plan, the role and objectives of the corps operation will be derived. A matrix will be constructed which identifies critical events and times for activities for which the corps is responsible. The elements of different echelons of the corps involved in the activities will be identified later during the analysis of the corps operations plan. Information must be gathered at this time to determine the structure of the corps, organization of the corps staff, and SOPs of the corps staff actions. This information is required because these factors vary from one corps to another. Observers will then focus their attention on the primary staff elements of the corps involved in development of the corps operations plan, particularly the G2, G3, and G4 elements. The focus of these observations will be on information processing with data collection including time required to gather, process, and disseminate information and orders.

Once the corps operations order is developed, this order will be analyzed to construct an event timeline of key battlefield events and their interrelationships. This timeline will be constructed on a micro-computer and will be used to determine the degree of synchronized activity called for in the corps operations plan. Using this battlefield event timeline, a second timeline will be constructed which identifies critical staff events which must occur in order for the battlefield events to occur as planned. This latter timeline will be used to identify critical staff elements, staff integration required to implement the operation, likely information flow patterns and critical information processing nodes for the operation. Given the current structure of REDCOM exercises, all of the above processes would be completed prior to the actual time at which the exercise is scheduled to start. Thus, observations of staff planning and development of the corps operations plan would need to occur at the players' home-station location. No attempt to observe such corps planning activities is currently undertaken by REDCOM.

In addition to the battlefield event timelines developed for the Army Corps participating in the REDCOM exercise, a parallel battlefield event timeline will be constructed for the Opposing Force (OPFOR) operations plan for the exercise. This timeline will identify all of the key events and interrelationships which are contained in the OPFOR plan of operations. This timeline will be an important source of information used for feedback to the corps.

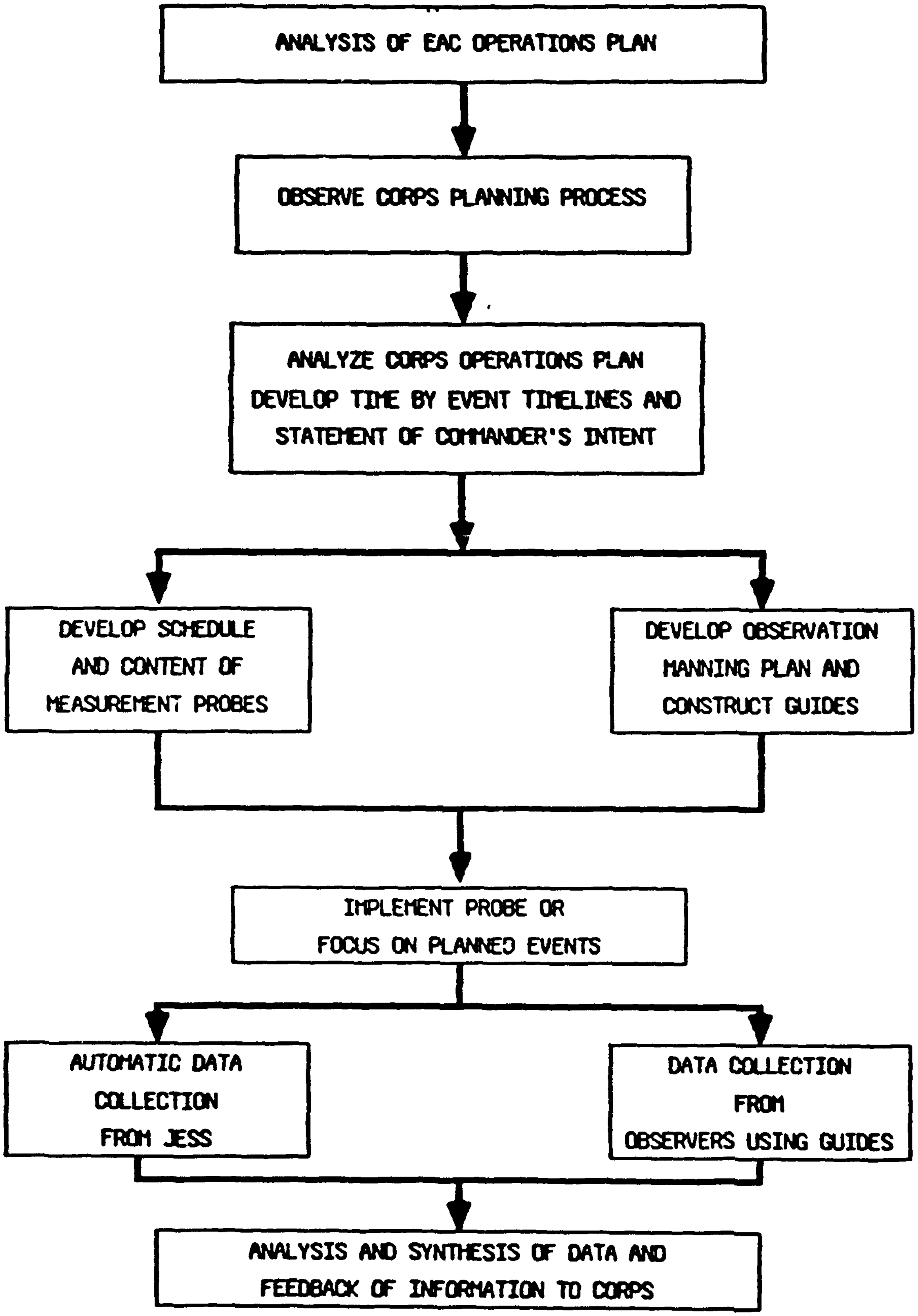



FIGURE 7-1. Schematic Of Measurement Process

Based on the corps operations plan and the op order delivered by the corps commander, the observation team must construct and verify with the corps commander a concise statement of the commander's concept of the operation. This concept must include clear statements of the roles of the corps elements whose actions are essential to the successful execution of the plan. After verification of the plan, questions must be developed which can be answered by key players to provide an objective measure of the degree to which they understand the commander's intent and their role in the operation. The questions may be presented to the selected players in the form of oral questions or a short questionnaire administered at the end of the exercise.

After the battlefield event and staff action timelines have been constructed for both the Army Corps (Blue) and OPFOR, the next step in the measurement process would be to identify and schedule probe events for implementation during the exercise. Given the fact that the exercises are largely free play, it will probably be impossible to specify times at which probes are implemented. Rather, the relative order of probe implementation and various probe implementation contingency plans will be developed.

Concomitant with the development of the probe schedule will be the identification of critical observation points during various stages of the exercise. These observation points will represent various staff elements at different echelons. Observers must be assigned to cover these elements during certain planned corps actions and when activities stimulated by the probes are anticipated. Specific target behaviors to be observed must be identified and the appropriate observation guides assembled for observers manning the different observation sites. The observation guides will consist primarily of observer prompts and data recording forms which will be loaded into electronic clipboards that allow convenient recording of data. After observations have been made and recorded, the data can be automatically uploaded into the same micro-computers used to construct the event by time matrices.

The appropriate triggers for automated data collection must also be programmed into the exercise driver model prior to the exercise. Just as the probe schedule can be developed only loosely, the trigger programs for automatic data collection must be developed to allow manual initialization of the programs. Prior to the exercise it will be possible to program the identification of the types of data and elements (work stations) from which data are to be collected during various phases of the exercise or following the implementation of a particular probe.

Once the exercise actually begins, the measurement system will function as follows. At predetermined time intervals, during set periods of time following the insertion of a probe, and at times a senior observer makes special requests, the automatic data collection programs will record the following types of information from the exercise driver model (currently JESS):

1. Beginning time for data collection

2. Identification of BLUEFOR and OPFOR units in area of interest

3. Unit status of BLUEFOR and OPFOR elements (personnel strength, number and type of weapons systems, etc.)

4. Record of dispositions and movement of each BLUEFOR and OPFOR unit

5. Casualty and BDA reports if units are engaged in conflict

6. Listing of orders, messages, movement commands, etc. relevant to units under observation

7. Ending time for data collection

While the data elements listed above are recorded automatically, observers will be using electronic clipboards to record data from relevant staff elements involved in the actions of interest. The majority of the observations recorded will focus on actions of commanders and information processing actions of the staff. At regularly scheduled time intervals, all data recorded by observers on electronic clipboards will be uploaded on the micro-computer for processing and analysis.

At appropriate time intervals, printouts of the data collected automatically on JESS will be examined and certain events will be extracted and used to construct another battlefield event timeline of the corps operation as it is actually implemented. This timeline will be compared to the planned operation to determine MAJ or deviations from the plan and will be a critical part of the feedback system. Where deviations between the event timelines of planned and executed events occur, the deviations will be noted and relevant data on related staff and command actions collected by observers will be examined. A parallel battlefield event timeline of actual OPFOR events will also be constructed and compared to planned OPFOR events.

At the end of the exercise, the timelines of battlefield events and staff actions and supporting data gathered automatically and through observers will be compiled to provide feedback to key members of the corps. This processing of data will be facilitated by the computer-based system used to record data and construct the event timelines. The content of the feedback will, of course, vary from exercise to exercise depending on the nature of the operation and the manner in which the operation is executed. The basic structure or format for the feedback system will remain essentially the same, however. Two basic types of feedback will be given. The first will represent a narrative of the operation with feedback using the BLUE and OPFOR timelines illustrating events as they were planned and as they were actually executed. Accompanying this discussion will be various battle outcome data for the exercise as a whole and for selected engagements critical to the operation.

After discussion of what happened and presentation of data relevant to the level of performance of the corps as a (whole, the feedback will shift to a discussion of why the corps performed as it did. Feedback presented in this portion of the after action review will be structured in a backward audit fashion. The feedback will focus on a limited number of key events which the senior observer identified as critical to synchronization of the corps operations. The events will likely be related to probes which were inserted into the exercise. Starting with the outcome of these events, data will be presented to examine the sequence of battlefield events and staff actions related to the outcomes. Finally, the battlefield events and staff actions will be traced back to the probe (Intel information and/or OPFOR actions) which served as the stimulus for the event.

Electronic Clipboard Technology

In order to implement the measurement process described above, a number of measurement instruments or components of the system must be developed. The electronic clipboard technology to be used in recording observations has already been developed and pilot-tested by ARI. The clipboards make use of touch sensitive screens and menus to eliminate the need for typing of information. The clipboards also provide prompts and instructions for the observers and automatically time-tag data when it is entered into the machine. The clipboards presently operate for approximately eight hours on a rechargeable battery. Data recorded on the clipboard can be uploaded onto an IBM PC or compatible micro-computer. The specific observer prompts and data collection menus used with the clipboards can be downloaded into the clipboard using the same PC system. The content of the data collection menus and observer prompts is easily modified using word processing software on the PC.

Observation Guides

The development of the content of the observation guides to be loaded into the electronic clipboards will require that a number of tasks be completed. First, taxonomies of the type of information and/or actions to be recorded by observers must be constructed. Information will be categorized in terms of dimensions such as content (tactical, logistical, etc.), relative level of source (corps, above corps, below corps), whether the information is basically an input or output of the corps commander and his staff (i.e., intelligence information vs. a FRAG order), and/or the functional area through which information would enter or leave the corps (Intelligence, Maneuver elements, etc.) These different types of information represent potential targets on which observers might focus their attention after the occurrence of a probe.

In addition to a taxonomy of information which is defined in a militarily meaningful manner, the observation guides will contain a component which identifies potential information processing activities which may be of interest. Such processes may include relaying information, synthesizing information, analyzing information, transforming information (verbal to graphics, etc.). These processes will be translated from their conceptual information processing terminology into observable military behaviors which might be displayed by commanders and their staffs. This component of the measurement system will be combined with the information taxonomy to develop some form of structured observation guides or observation framework for observers and for use in development of data extraction programs for extracting data from the simulation model itself.

Another element of the performance measurement system related to the observation guides will be the observer training component. This training program will be used to familiarize data collectors with the concepts, technology, and measurement tools used in the corps performance measurement system. The training will include lecture, class discussion, and the use of videotapes to provide actual practice in using the observation guides. The videotapes will also be used to calibrate the raters and to collect data needed to evaluate the effectiveness of the training. Some observers may be eliminated if they do not successfully complete the training program and demonstrate acceptable interrater reliability in the use of observation guides.

Automatic Battlefield Event Data Collection Programs

The two components of the measurement system described previously will aid in collection of data related to the synchronization process as reflected in the behavior of commanders and their staffs. Additional measurement system components will be developed for collecting data on synchronization as it is reflected in the actions of units appearing on the computerized battlefield provided by JESS. These components will take the form of programs to be added to the exercise driver (JESS) which automatically record and save the information required to reconstruct the battlefield in terms of disposition and status of friendly and OPFOR units at pre-determined intervals of time. This will allow a reconstruction of "ground truth" for different phases of the operation. While not providing any direct measures of synchronization, the data produced by this component can be analyzed and/or synthesized to derive various quantitative measures related to rates of movement, etc. which may be used to calculate or infer relative degrees of synchronization of operations. Most likely, this will involve judgments relating unit dispositions and status during the operation to expected values derived from the OP Plan and commander's concept of the operation.

Battle Outcome Measures

The fourth component of the measurement system will be battle outcome measures produced by JESS. Such measures may be collected and saved throughout the exercise to allow assessment of the outcomes of key engagements which occur at different points in time in addition to the overall end of operation outcome measures.

The Probe System

The four components of the measurement system described above, represent passive components of a non-obtrusive data collection system. A fifth component of the measurement system is the probe subsystem. This system differs from the other components in several ways. First, it must be included as part of the design of the exercise itself. Second, it has a direct impact on the conduct of the exercise and the players in the exercise. Finally, just as JESS is the driver for the corps-level exercise, the probe subsystem is the "driver" for the measurement system. The probe system will be constructed to generate a variety of events/information which can impact directly on different command and staff elements at different echelons. The probes will be entered through JESS in the same manner as other exercise events, often in the form of specific OPFOR actions. The probe system will also include the guidelines for placement of observers at particular information processing nodes as well as procedures for alerting observers that the probe as been implemented. The occurrence of the probe event may also serve as a trigger for data collection programs which are built into JESS as part of the automatic data collection system.

While the actual performance measurement data and data collection procedures will be treated in more detail in later sections, it is important to examine the probe subsystem in some detail at this point. The actual nature of any probe event or sequence of events will be tailored specifically to each REDCOM exercise. The insertion of such events is routinely included as part of the exercise. The difference between the use of such probe events in the past and those included in the current measurement system is that detailed data collection efforts will be cued to the implementation of the probe in the current effort. Figure 7-2 provides a schematic of the manner in which the probe subsystem will operate.

As noted earlier, a probe may consist of a single event such as the movement of a particular OPFOR element or implementation of an unexpected OPFOR event such as the use of chemical weapons or a sudden air strike. Alternatively, a probe may be represented by a *sequence of events* or sequence of INTEL messages which, if synthesized and interpreted correctly, provide critical information regarding the corps operation. The probes will be constructed and entered into the system in such a manner that certain staff elements should be stimulated.

Given the focus on synchronization, those staff elements at corps level involved in battlefield synchronization will be the most likely groups to be targeted for stimulation by probe events. According to FC 100-15, Corps Operations the staff elements most directly involved in synchronization of the corps battle include:

- The corps commander or his designated representative

- The G-3 staff

- The G-2 staff

- The Fire Support Element representative

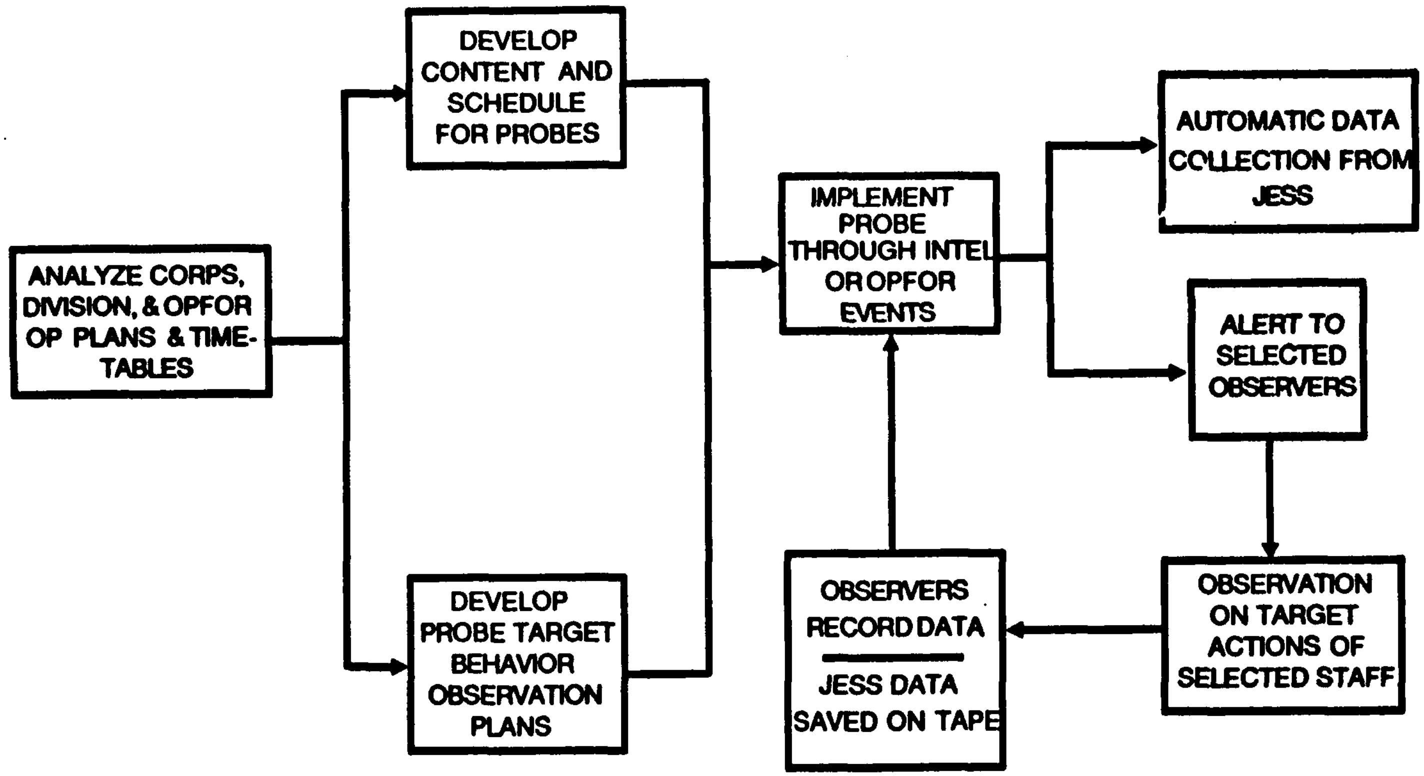



FIGURE 7-2. REDCOM Probe System Process

- The tactical air control party staff
- The electronic warfare section
- Other service representatives

If probes are inserted to examine the ability of the corps to maintain synchronization of activities in response to a changing battlefield, observers will most likely be assigned to examine the response of the staff elements listed above. Observers at these staff elements would be alerted when the probe event occurs and would have observation guides with prompts identifying specific target behaviors for observation. The observations would be recorded on the electronic clipboard and automatically time-tagged. During this observation period, data would be automatically extracted from JESS to record battlefield events and relevant messages and orders entered by controllers at the JESS workstations. The next section of the report provides much greater detail regarding the actual data which might be collected during REDCOM exercises and the manner in which the data will be transformed into measures of performance for feedback to the corps commander and his staff.

# SECTION 8
# DATA COLLECTION, ANALYSIS AND SYNTHESIS FOR THE CORPS PERFORMANCE MEASUREMENT SYSTEM

## Overview

The exact content of the battlefield event timelines, observation guides, probes, and other measurement tools used in the corps performance measurement system will be tailored to each REDCOM exercise. While this means that it is impossible to present specific measurement instruments with the exact items to be used, it is possible to provide considerable detail on the types of data and data collection procedures used in the performance measurement system. In addition, it is possible to discuss the manner in which the data will be synthesized and analyzed to derive the measures of performance which provide the basis for the feedback system. This section of the report will provide as much detail as possible regarding the data collection procedures and data analysis procedures required to derive the measures of performance called for by the measurement concept presented in Section 7.

The corps performance measurement system will involve collection of six types of data. The data to be collected include:

- Information on the structure, SOPs for staff actions and other relevant data on the corps participating in the REDCOM exercise
- Overall combat outcome measures generated by JESS
- Selected engagement outcome measures generated by JESS
- Battlefield event and action data extracted from JESS
- Staff actions, products, messages, reports, etc. extracted from JESS and collected/recorded by observers
- Answers to objective questions collected either verbally or on surveys from players during and/or after the exercise.

Each of these types of data is described in the paragraphs below. Following the description of each of the individual measures is a discussion of the manner in which the data will be analyzed and synthesized to derive measures of corps performance.

## Corps Structure and SOPs

As noted earlier, Army corps are structured to meet the needs of particular theater missions and contingency plans. Furthermore, the SOPs used by the staff to accomplish a variety of actions related to the processing of critical information may vary widely. To aid in the development of observation guides and placement of observers during the exercise, it will be important to collect data on the structure of the corps staff and SOPs used by the staff. This data will be collected during a home-station visit prior to the start of the REDCOM exercise.

## Combat Outcome Measures

As noted earlier, extreme caution must be observed in using combat outcome measures produced by a model such as JESS. Nonetheless, such measures must be incorporated in the corps performance measurement system. The majority of the data required to examine combat outcomes can be taken directly from summary reports generated by the JESS. The basic data which will be extracted from JESS to examine combat outcomes include:

1. Location and status of all units (BLUE and RED) at the start of the exercise

2. The final location and status of all units (BLUE and RED) at the end of the exercise

3. Total personnel casualty figures for BLUE and RED forces by the smallest unit of analysis possible (probably Bn)

4. Total BDA figures for all weapon systems (air and ground) of both RED and BLUE forces. If possible, this will include information about the type of system making each kill.

5. All logistics data on ammunition, fuel, food, etc. used by the Corps during the operation.

6. Data on all supplies, etc. which were partially or totally distributed but not consumed, never distributed, etc.

7. All available data on RED casualties inflicted by each BLUE unit (by smallest unit possible).

8. Start and end times for the exercise

9. Summary data on fire support missions

10. Summary data on all air missions

Selected Engagement Outcome Data

During periods of data collection following the implementation of probes and at predetermined periods of focused observation suggested by the planned event timelines, outcome data from selected engagements and/or battles will be collected from JESS. The data to be collected for these engagements includes:

1. Identification and location of all units involved in the battle or engagement

2. Start time for the engagement

3. Complete unit status of all units at the start of the engagement

4. Complete records of all casualties, BDA, etc. produced during the engagement for all units involved

5. Ending time for the engagement

6. Final unit status for all units involved in the engagement

7. Final locations of all units involved in the engagement immediately following the end of the engagement

8. Summary data on all air and fire support missions called for during the engagement by both RED and BLUE forces

Battlefield Event and Action Data

Following the implementation of probes or based on predetermined periods of focused observation, selected battlefield event data will be extracted from JESS. The target events will be selected based on the BLUE and RED event timelines and anticipated responses to probe events. The exact means by which the data will be extracted cannot be specified at this time. One option is to alter the JESS program to dump all graphics and message data onto tape for later playback. A second option is to clearly specify target events or actions and place an observer at the master control workstation to observe all graphics and message traffic. When the event occurs the observer could make all necessary records manually. Assuming that an automated recording system can be developed for the JESS, the following types of data will be recorded (depending on the nature of the target event or action):

1. Snapshot of the entire graphics (locations, movement, of all units at the time of the event)

2. Magnified snapshot of the area in which the event occurs

3. Complete location and unit status data of all elements involved in the event

4. Starting and ending time of the target event

5. Any relevant outcome data produced by the event (See list of selected engagement outcome data above)

<u>Staff Actions, Reports, Messages, etc.</u>

At selected times after implementation of probes or based on the staff event timelines developed from analysis of the corps operations plans, observers will make detailed recordings of staff information processing actions. In addition, the observers may obtain copies of selected messages, reports, etc. produced by staff members. All operations plans, written orders, etc. will be collected on a routine basis. The data collected by observers will take three different forms.

The first type of data is observations related to staff information processing behaviors. These observations will be recorded using the electronic clipboards described earlier. While the exact nature of the data collected will be determined by the nature of the corps operation, it will most likely include the following generic elements:

1. Time of the observation

2. Type of information processing action observed (gathering information, relay, transformation, analysis, synthesis, etc.)

3. Staff element under observation

4. Essential characteristics of information being processed:

    - Type of information
    - Source

- Media
- Etc.

5. Outcome of the staff action

6. Perceived objective of the action

7. Use of SOPs

8. Time information or information product was passed to other staff elements

9. Identification of staff elements where the information or products were sent

10. Media or means by which the information was sent to other staff elements (radio, phone, written message, etc.)

The second type of information gathered by observers will be copies of messages, reports, plans, orders, etc. which are clearly related to target events or target staff actions. While the reports will not be physically collected at the time the observer notes their existence, records of their existence must be noted and arrangements should be made with the exercise controllers to obtain copies as soon as possible. An essential element of data which observers must collect will be photographs or detailed notes on the situation maps of various corps staff elements (particularly the G-3 and G-2) during critical points or phases of the operation. These maps will be compared to "snapshots of ground truth" taken automatically from the JESS.

A third type of data to be collected by observers during focused periods of observations will be hard copies of controller input and reports produced by JESS. These printouts will be collected from selected workstations representing the staff and/or maneuver elements on which observations are centered. Since each workstation has a printer, this will produce no particular burden on the controller. Furthermore, each entry and report is automatically time tagged by the JESS. Examples of the type of data which will be collected using this method include:

1. Controller commands to move units

2. Controller requests for unit/logistics status based on requests from players

3. Controller commands to change task organization

4. Controller requests for supplies, etc.

5. Controller requests for fire support missions

6. Breaching of minefield commands

7. Controller requests for air support

8. Requests to draw supplies

9. Crossleveling of supplies requests

10. Request to create supply convoy

11. Orders to change maintenance support unit

Player Answers to Objective Questions

The final type of data to be collected during the REDCOM exercise will be data collected from key players on the corps staff and division commanders and staff members. The information will be in the form of answers to a small number of objective questions designed to assess their understanding of the corps commander's concept of the operation and his intent. While these questions will obviously be tailored to each exercise, the general purpose of the questions will be to determine the extent to which each key player understands:

1. The overall intent or objective of the corps mission (as stated by the corps commander)

2. The role of his organizational element in the corps operation

3. The timing or importance of key events or actions in which his organizational element is involved

4. The objective or intent of specific key events

5. Any specific requirements for his organizational element with regard to location at a particular point in time

6. Requirements for coordination/synchronization of his actions with those of another element in the operation

7. Requirements or importance of sharing specific types of information with other individuals or organizational elements.

The data concerning understanding of the commander's intent and concept of the operations will be collected from players in such a way as to avoid any interference in the actual conduct of the exercise. This may mean that data cannot be collected from certain key players until completion of the exercise. While this may create some problems because the players have developed very keen hindsight, it is a problem which is unlikely to be easily solved, particularly if data is to be collected from division commanders and/or division and corps principal staff officers (G-3 and G-2).

Data Integration and Derivation of Measures of Performance

The data described above represents the raw material used in the derivation of the measures of corps performance which will be used in providing feedback to the corps commander and his staff. This section of the report will provide as much detail as possible on the manner in which the raw data will be analyzed and synthesized to derive the performance measures. The discussion will begin with the criterion measures which will be used to provide feedback as to "how well" the corps performed.

Criterion Measures

Most of the criterion measures will be obtained directly by summarizing or combining combat outcome data arithmetically. Not all measures will be presented for each corps operation. The importance of a particular outcome measure is dependent on the nature of the mission which the corps is performing. The outcome measures will be organized around the structure provided by the attributes involved in a MET-T type of mission analysis. This mission outcome structure was developed as part of the NTC performance measurement system and has met with considerable support as a meaningful way to analyze outcome data. Figure 8-1 provides the general structure for synthesizing and presenting the outcome data. The first two columns of the outcome data matrix will be completed based upon an analysis of the corps operations plan and discussions with the corps commander as to what he considers to be acceptable standards for successful completion of the mission as measured by the attributes of terrain, resources, and time. The criterion measures used to complete the matrix and the manner in which they will be calculated from the raw data are listed below. Unless stated otherwise, the outcome measures will be taken directly from summary reports generated by the JESS and will require relatively little transformation. The data used to complete the data synthesis matrix illustrated in Figure 8-1 will include:

| MISSION STANDARDS | | | | PERFORMANCE MEASUREMENT | |
|---|---|---|---|---|---|
| Attribute | | Purpose of Mission | Standards | Data Requirements | Measures of Preformance |
| TERRAIN | | | | | |
| RESOURCES ENEMY | Troops | | | | |
| RESOURCES ENEMY | Equip ment | | | | |
| RESOURCES FRIENDLY | Troops | | | | |
| RESOURCES FRIENDLY | Equip ment | | | | |
| TIME | | | | | |

FIGURE 8-1. Structure For Synthesizing Outcome Measures

**TERRAIN:**

Territory Gained or Lost:

Calculated from Original Positions and Final Positions of BLUEFOR AND OPFOR units

**RESOURCES:**

Friendly (BLUE) Resources Data

- Blue Force Casualties:
  - By Battalion
  - By Bde
  - By Division
- Total

- Blue Force BDA:
  - By Unit and System
  - Total By System

- Total BLUE FORCE Ammunition expended:
  - By unit by Type
  - Total by type

- Fuel Expended:
  - By unit
  - Total

Enemy (OPFOR) Resource Data

- OPFOR Casualties:
  - By Unit
  - Total

- OPFOR BDA:
  - By unit and system
  - Total by system

- Total BLUE FORCE Ammunition expended:
  - By unit by Type
  - Total by type

- Fuel Expended:
  - By unit
  - Total

**TIME FACTORS:**

Time to Reach Objective (BLUEFOR OFFENSIVE MISSION). Calculated from the time the exercise begins to the time the forward maneuver elements of the corps has occupied the hex at the center of its objective (or end of exercise).

Rate of Movement for the Corps (BLUEFOR OFFENSIVE MISSION). Calculated by determining the average distance traveled by forward maneuver elements from their starting to ending locations and then dividing this distance by the time taken to reach the objective (above).

Time Required for the OPFOR to Reach Objective (BLUEFOR DEFENSIVE MISSION). Calculated from the time the exercise begins to the time the forward maneuver elements of the OPFOR have occupied the hex in the center of their objective.

Mission Accomplishment

The corps commander or the director of the REDCOM exercise may wish to make a general statement concerning the extent to which the corps has accomplished its mission. Such a statement may be a simple yes or no type of answer for a relatively straightforward mission or a fairly complex answer which requires certain qualifying statements for a complex mission. In any case, the judgment will probably be based on an assessment of all of the criterion measures described above plus the corps commander's assessment of the standards which define successful performance on each of the criteria.

Performance Measures and Synchronization Indices

The second group of performance measures are those which provide an objective "picture" of the unfolding of the operation and the degree to which the operation was executed as planned. These measures are derived indirectly from the raw data. Figure 8-2 provides a schematic of the process used to derive the performance measures. The operations plans are first analyzed to construct an event timeline with synchronization relationships.

Based on the battlefield events included in the timeline, a planned staff action timeline is derived based on inferences as to staff actions and timing of staff actions required at corps level to execute the battlefield events in the operations plan. While construction of the planned battlefield event timelines is a fairly objective task, the construction of the latter predicted staff action timeline requires extensive knowledge of corps staff

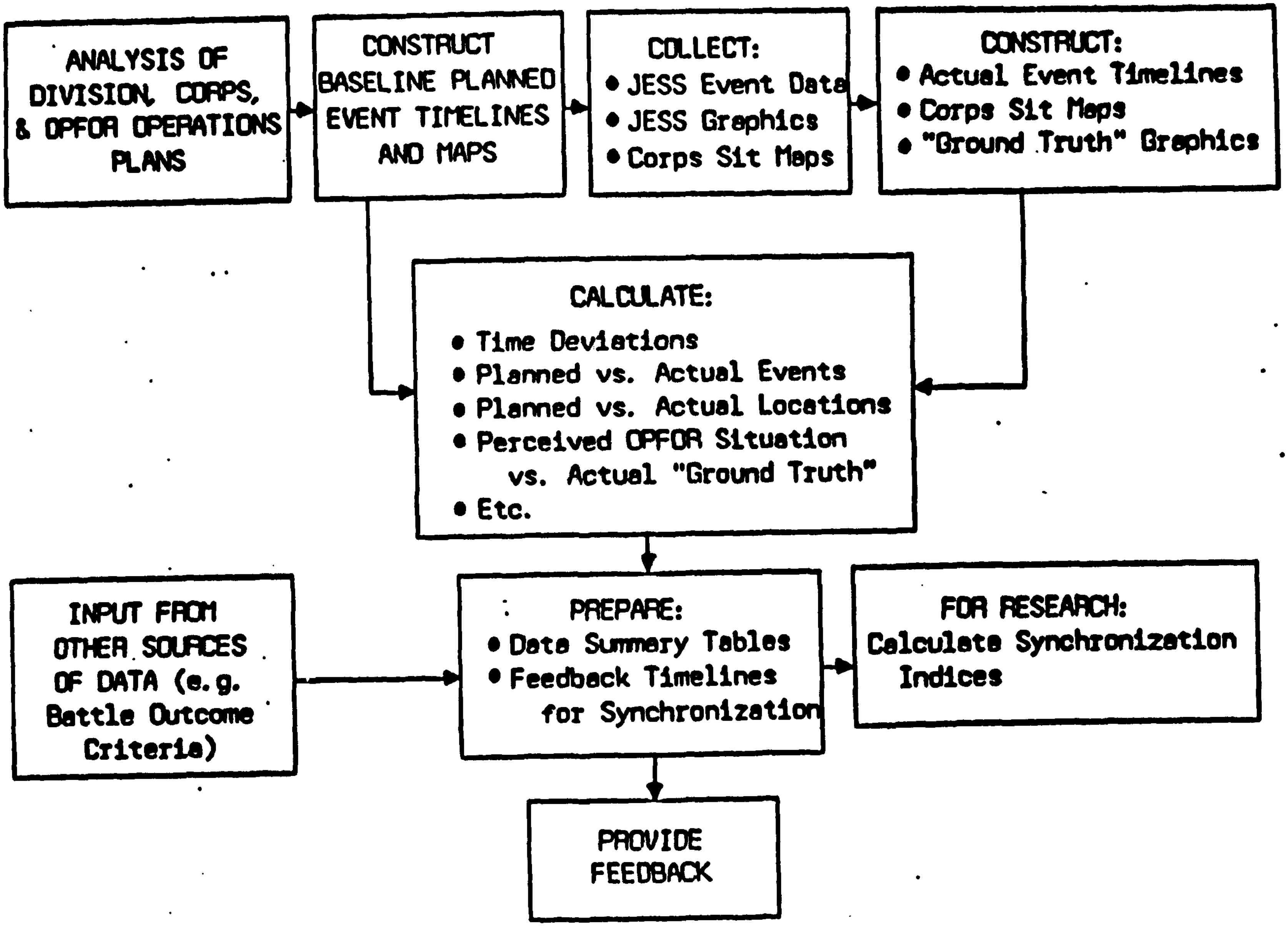



FIGURE 8-2. Derivation Of Performance Measures

operations as well as knowledge concerning the SOPs for staff operations in the corps being assessed.

Accompanying the battlefield event timeline should be a complete copy of the corps control graphics with symbology and information of projected unit locations at critical times during the operation. These three tools represent the baseline data from which calculations will be made to assess synchronization of the corps operations.

As noted previously, a parallel OPFOR battlefield event timeline will also be constructed. Accompanying this timeline will be a map with all relevant OPFOR graphics.

After the exercise has been completed, the battlefield event and action data extracted from JESS and the staff action data collected by observers using electronic clipboards will be used to construct a second set of event timelines. The second set of event timelines will consist of actual battlefield events and actual staff actions related to the corps operation. The photographs, observer notes, and unit locations reports extracted from JESS at particular stages in the exercise will also be synthesized to form a set of "ground truth" situation maps.

Simply presenting the actual battlefield event and staff action timelines and "ground truth" situation maps will have significant feedback value for the corps. In addition to such qualitative summaries of raw data, the following quantitative measures of performance will be calculated:

- Percentage of planned events successfully executed during the elapsed time of the exercise. This will be calculated by dividing the total number of discrete events identified on the baseline battlefield event timeline by the number of these events which are successfully accomplished as indicated by the actual battlefield event timeline. The definition of successful completion will be based upon the corps commanders' prior statements concerning mission standards and the selected engagement outcome data extracted from JESS.

- Time deviations for planned and actual events will be calculated based on the baseline and actual event time lines

- Number of unplanned key events. This measure of performance may take several forms. It will be derived based on observations and data extracts from JESS made during observation periods following probes and other predetermined observation periods. The events will be found on the actual event timeline and may include probe events, unexpected BLUEFOR actions (positive or negative), and unanticipated OPFOR actions. This data will be presented to stimulate discussion of contingency planning, actions demonstrating initiative and understanding of the commander's concept, etc. The OPFOR battlefield event timelines and graphics will be particularly important for this feedback.

- Deviation in planned and actual unit locations will be calculated based on the baseline map and actual situation maps. A limited amount of this data will be calculated and presented. The data will be presented only for instances in which unit location appeared to be a major factor affecting synchronization (or lack thereof of the operation).

- Qualitative comparisons or simple presentation of photographs or copies of the G-2 and G-3 sitmaps and snapshots of "ground truth" of the situation extracted at key points in time from JESS will be used to demonstrate the accuracy of the intelligence process and corps processing of information.

Synchronization Indices

Examination of the battlefield and staff event timelines and the corps operations graphics and "ground truth" sit maps should allow a qualitative assessment of the degree of synchronization required and achieved in an operation. The authors recommend that the timelines should be used as the primary source of feedback on synchronization to the corps.

On the other hand, the authors also recognize that some quantification of synchronization may be desired for research purposes. Two potential indices may be derived from the use of data collected in the proposed performance measurement system. The first index represents a measure of the degree of synchronization required in the plan for the operation while the second represents an indication of the degree of synchronization achieved. The reader should be cautioned that the methods for calculating these indices have yet to be tested and are related to the operational definition of the synchronization concept discussed earlier in the report.

Synchronization Required in Plan

The calculation of this index requires the use of the BLUE battlefield event timeline, the operations graphics, and a copy of the concept of the operation. The index is calculated using the following equation:

Req. Synch. = (Percent of Cross Functional events + Percent of coordinated location events) x Time criticality factor

Where:

The percent of cross functional events is equal to the total number of events on the planned battlefield event timeline that are linked across functional areas divided by the total number of events on the timeline.

The percent of coordinated location events is equal to the total number of events on the planned battlefield event timeline that the corps graphics and operations plan call for supporting actions by at least two battalion size units or elements from two different battalion size units which must be in particular locations divided by the total number of events on the same timeline.

The time criticality factor is equal to the sum of the time criticality values for all cross-functional events divided by the total number of cross-functional events. The time criticality value for a cross functional event is a an indicator of the extent to which the actions of the cross-functional elements must be synchronized in time. The values are assigned using the information in Table 8-1.

Table 8-1. Time Criticality Values

| Degree of Time Synchronization n Plan | Time Criticality Factors |
|---|---|
| Window for synchronization is one hour or more | 1 |
| Window for synchronization is between 30 minutes and 59 minutes | 2 |
| Window for synchronization is between 15 and 29 minutes | 3 |
| Window for synchronization is between 7.5 and 14 minutes | 4 |
| Window for synchronization is less than 7.5 minutes | 5 |

## Synchronization Achieved in the Operation

This index measures the degree of planned synchronization in the operation which was actually accomplished in the execution of the operation. This index is calculated using the following equation:

Synch Achieved = (Percent of actual cross-functional events + Percent of actual coordinated location events) x Actual time synchronization factor

Where:

The percent of actual cross-functional events is equal to the total number of events in which the planned cross-functional actions occur divided by the total number of planned cross-functional events.

The percent of actual coordinated location events is equal to the number of planned coordinated action events when all units are at planned locations divided by the total number of such events that were planned.

The time synchronization factor is equal to the product of the percentage of planned events requiring time synchronization which are executed within the allotted time window multiplied by the average time criticality factor of the successfully executed events.

Once again, it must be stressed that these are only tentative indices of synchronization which are to be used for research purposes, not for feedback to the corps. The indices are simply a means of summarizing data related to the elements of synchronization (concentration of effects in time and space) identified in the review of doctrine. If research indicates that the indices provide a valid measure of synchronization then they may later be used as a summary statistic provided as feedback.

## Diagnostic Process Measures

The third group of performance measures are those measures which aid in explaining why operations did not go as planned. The bulk of these measures focus on the data from observations and automatic data collection on information processing variables and the questionnaires examining the understanding of the commander's intent and concept of the operation.

The first group of these diagnostic measures includes data related to the degree to which subordinate commanders and the corps staff understood the corps commander's intent and concept of the operation. The measures will be calculated from scores on the objective questions answered by players and include:

- The percentage of players surveyed with accurate answers to each question;

- Some measure of the average degree of discrepancy present in incorrect answers concerning location, time, or other quantifiable attributes of the operation;

- Frequency and percentages of the types of discrepancies found in the players answers.

The second major group of diagnostic measures are measures of information processing performance collected by observers following the insertion of probes. This information will include two types of data. The first will be a flow chart similar to a staff action micro-timeline which traces all available data on the actions of the commanders and staff stimulated by the probe. The second type of data will be average values for the performance of the staff on various aspects of information processing measured by observers. This information will be presented by each major staff element assuming adequate data has been collected for each element during the exercise. The data will include:

- Frequency and percentages of various types of information processed by each staff element;

- Frequency of occurrence and percentage of time spent by various staff elements in various types of information processing behaviors (gathering, relaying, synthesizing, etc.)

- Average times required to complete various types of information processing activities

- Average time required for communication of information to and from different staff elements

- Percentage of observed staff actions following corps SOPs

- Cross tabulations of various information processing measures by Actions following or not following SOPs.

## Summary

The data elements and performance measures described above represent a first-cut attempt at the development of operational measures of corps performance related to the synchronization-based model of corps performance presented in Figure 4-3. Table 8-2 presents the eight performance factors identified in the corps performance model. The measures of performance described above will provide feedback to the corps commander and his staff on five or possibly six of these performance factors. More specifically, the measures of performance will allow the following questions to be addressed concerning corps performance:

1. The extent to which the commander has communicated and his subordinates have understood the commander's intent and concept of the operation.

2. The degree to which the staff coordinates and synchronizes their actions in completing the corps operations plan and during the execution of the plan.

3. The extent to which various elements of the corps execute their assigned missions as measured by the selected outcome measures extracted from JESS and actual battlefield and staff event matrices constructed from various data.

4. The ability of commanders and staff to adjust to changes as measured by information processing and command actions following the implementation of probe events.

5. The degree to which commanders and their staffs plan and coordinated logistical support to maneuver elements as measured by admin/log reports extracted from JESS.

Three additional performance factors contained in Table 8-2 are not directly addressed by the proposed corps performance measurement system. The nature of the REDCOM exercise environment and practical considerations regarding the nature of feedback likely to be acceptable to players in a corps exercise preclude the development of measures of performance for the performance factors of adequacy of information used as input to the corps plan, soundness of the corps operations plan, and the degree to which communications are maintained during the operation.

The nature of the REDCOM exercise does not allow one to examine the corps intelligence process which would normally gather information used as input in the development of the corps plan of operations. Currently, this information will be supplied by REDCOM. In the future, if JTLS is used for situation development, it may be possible to evaluate this performance factor.

Table 8-2. Performance Factors Identified in Corps Performance Model

- Accuracy and completeness of information used to develop the corps operations plan
- Soundness, adequacy, etc. of the operations plan developed by the commander and the G-3
- The degree to which the plan and intent of the commander is clearly communicated and understood by subordinate commanders and the corps staff
- The degree to which the corps staff coordinates and synchronizes their actions in preparing for and implementing the plan
- The extent to which subordinate echelons (particularly the maneuver elements) execute their assigned missions
- The degree to which lateral and vertical communications are maintained during execution of the operation
- The ability of the commanders and staffs, particularly at upper levels (division and corps) to adjust plan in response to changes on the battlefield
- Logistical support to maneuver elements

No attempt is made in the current performance measurement system to evaluate the soundness or adequacy of the corps operations plan. While the planned battlefield event and staff action matrices provide a very explicit diagram of the plan, the authors do not consider it feasible for the controllers involved in the REDCOM exercise to pass judgment on the adequacy of the plan. If the plan is executed well and the result is failure, problems with the plan are likely to become self-evident. If the plan is not executed well, it is likely to be difficult to pass any judgment on the plan with the exception of an assessment that the plan was too complex for successful execution. In either case, such judgments should be made by the corps commander and his staff; not the observers and controllers in the exercise.

The final performance factor not directly addressed by the proposed measurement system is the degree to which vertical and horizontal communications are maintained during the execution of the operation. The primary focus of this factor as described in the model is on tactical communications which allow lateral coordination among maneuver elements and vertical communication of spot reports and orders. The recording of such communications is difficult and not realistic in the Bold Venture exercises which are primarily CPXs. On the other hand, the degree to which communications are maintained in the FTX portion of the Bold Eagle exercises should be noted by observers and assessed at least qualitatively during actions which required lateral coordination of maneuver elements.

While an initial illustration of the viability of portions of the measurement concept and data collection procedures described in Sections 7 and 8 was demonstrated through the Inchon Landing example, the measurement concept and data collection and analysis procedures require extensive validation. The final section of the report presents a plan for conducting this evaluation and validation of the measurement concept for assessing corps performance.

# SECTION 9
# VALIDATION APPROACH

## Introduction

The final step in the development of an organizational performance measurement system is the validation of the performance measures and assessment of the utility of the feedback system. Validation of any performance measurement system is typically a difficult task. The basic problem involved in validation of a performance measurement system is that the system being validated was probably developed because there were no acceptable performance measures already in existence. Therefore, in most cases, it is not practical to use a criterion-related validation design to validate performance criterion measures--there are no measureable criteria to validate the performance measures against.

While difficulties exist, there are a number of ways to evaluate (if not validate) a performance measurement system. Typically, the evaluation should take place in two phases. The first phase of the evaluation represents a formative evaluation. In this phase, the major focus is to collect information regarding problems involved in the actual implementation of the performance measurement system. The attempt is not to evaluate the quality of the data produced by the system. Rather, the objective is to examine problems which may arise in the collection of data. This evaluation would include careful observation and recording of problems such as lack of clarity in observer instructions, hardware or software problems in automated data collection programs, logistical problems in providing support to observers, the need for more observer training, evaluation of potential interference in organizational performance created by the measurement process, etc. The results of the formative evaluation can be used to revise performance measures, develop new measures or data collection procedures, eliminate problem measures, identify data collector training requirements, or perhaps to make a decision on the feasibility of implementing any performance measurement process.

The second phase of the performance measurement evaluation process is the summative evaluation phase. During this second phase, the evaluation should focus on the quality of the data produced by the system, user reactions to the system, and the extent to which the performance measurment system meets the oriainal design requirements or objectives. The summative evaluation phase includes an assessment of the "validity" of the performance measurement system.

## Criteria for Criteria

Before addressing the specific evaluation design for the corps performance measurement system, it is important to consider the range of potential criteria which miaht be used to evaluate an oroanizational oerformance measurement svstem. As noted bv Bernardin and Beattv (1984), there are a varietv of criteria which can be used to assess a performance measurement system. In selecting the criteria used in the evaluation, it is important to keep in mind the purpose or objectives of the performance measurement system. The criteria selected for evaluation should provide data related to how well the performance measurement svstem meets the obiectives for which it was develoоed.

The current authors were able to identifv at least six criteria which miaht be considered in the evaluation of a perforamnce measurement system such as the corps performance measurement system developed in the current research effort. The first two criteria are traditional psychometric criteria which may be quantified using various statistical and psychometric procedures. The four remaining criteria vary in terms of the degree to which they may be quantified and the degree to which they represent psychometric vs. organizational concerns regarding the performance measurement system.

The first criteria to be examined with regard to any measurement procedure or instrument regards the reliability of the measurement process. Reliability refers to the stability or consistency of the measurement process. Traditionally, reliability is measured in one of three ways: test-retest procedures (stability over time), internal consistency of items purported to measure the same construct, or interrater reliability (consistency in ratings across different observers making the same observations).

The dynamic nature of the phenomena under study in the current effort (corps performance) negates the possibility of using any form of test-retest reliability measures to assess the performance measures. The exception to this might be an assessment of the reliabiltiy or variability of combat outcomes produced by probablistic algorithms used in JESS. At the current time, the authors are not aware of data documenting the variablity produced by such factors. The limited number of "instruments" or questionnaires used in the corps performance measurement system limits the applicability of internal consistency measures of reliability also.

On the other hand, measures of the degree to which there is interrater agreement in the observer recording procedures is a critical factor to be examined in the corps performance measurement system. As noted earlier, observers will require training to use the corps performance measurement system. Part of the training should include the use of video tapes to calibrate the raters and assess interrater reliability. Multiple observers should be used during the validation period to examine the interrater reliability of the various observer procedures and instruments in a field environment in addition to the data collected during rater training.

The second traditional psychometric criterion to be used in evaluating a measurement procedure is to examine the validity of the system. As noted above, problems arise in using the standard criterion related validity strategy. If independent measures of corps performance exist which are considered reliable and valid, the measures produced in the current system could be correlated with these other criterion measures. The authors recognize that such measures do not currently exist and are not likely to exist unless the United States Army becomes engaged in an actual armed conflict. Other validition strategies offer more opportunities. Perhaps the most likely validity which might be demonstrated would be content validity. Content validity refers to the extent to which the actual performance domain of the organization has been sampled adequately by the measurement procedures used in the performance measurement system. When establishing content validity of an individual performance measurement system, the evidence used to demonstrate content validity is a thorough job task analysis. The doctrine review and use of subject matter experts in development of the current corps performance measurment system provide some evidence of content validity. More systematic and comprehensive collection of data on critical tasks and functions performed at the corps level would provide additional evidence regarding content validity. Unfortunately, there is no single statistic such as a correlation coefficient which represents a measure of content validity. The degree to which such validity has been established requires a subjective judgment based on all available data described above.

A final option with regard to establishing validity of the performance measures is to use a construct validity approach as represented by demonstration of convergent and divergent validity. This approach requires that the researcher use multiple methods and measures to develop a network of correlations which should contain both significant and nonsignficant relationships with the performance measures being evaluated. If the performance measures are "construct valid" they should have higher correlations with other measures of similar performance constructs than with similar measurement procedures which purportedly measure different constructs.

Another criteria which may be used in the evaluation of a performance measurement system is the degree to which the organizations being assessed show variability on the performance measures. An assumption made in the use of this criteria is that performance measurement systems which allow one to discriminate levels of performance among different organizations are more effective measurement systems. This criteria is particularly important when the performance measurement system has been developed for evaluative purposes such as assessment of unit readiness.

A fourth criteria to be considered in evaluating the performance measurement system is the user acceptance and user reaction to the system. This criteria includes an assessment of user reactions and evaluations of the utility of feedback provided by the performance measurement system. To a certain extent, the user reactions are likely to be related to the degree of face validity of the performance measures and the degree of perceived relevance of the feedback to the organizational members' personal and organizational goals. Criterian is particularly important when the performance measurement system has been developed for training purposes.

A fifth criteria which must be considered in an organizational performance measurement system such as the corps performance measurement system is the cost and ease of use of the system. The cost must be considered in terms of capital outlay, personnel costs, time, etc. The personnel costs must be examined carefully in terms of the types of qualifications required for observers as well as the number of data collectors required. Often, the practicality of a system is limited if it requires sophisticated skills for observers.

The final criteria which should be assessed in the evaluation of a performance measurement system designed for training purposes is whether feedback from the system has a positive effect on subsequent performance. This may be difficult to assess in instances such as the REDCOM exercise environment in which feedback will not be provided until after the exercise is complete.

Evaluation Strategy for the Corps, Performance Measurement System

The evaluation strategy the authors recommed for the perfomance measurement system developed in the current research effort is a three-phase evaluation strategy. The reason for the three phased rather than a two phased approach is that the current system actually represents a measurement concept rather than a fully developed measurement system. The measurement concept requires further evaluation before the authors recommend full-scale development of the measurement system iteself.

Validation of the Measurement Concept

The evaluation of the viability and validity of the measurement concept has already been initiated. The first two steps taken in this effort were the review of the concept by knowledgeable military SMEs with the appropriate corps and EAC experience and the application of the synchronization measurement concept to the Inchon Landing. The next step in the evaluation of the measurement concept should be an assessment of the feasibility and adequacy of the measurement concept based on first-hand observations of the REDCOM Bold Venture 87 exercise by a team of researchers and military SMEs familiar with the measurement concept. This assessment will be highly sujbective in nature but will provide valuable insights for the development of the measurment system itself, assuming that the concept is judged to be valid.

The research team should develop a set of specific questions to be answered by their observations and interviews conducted with players and controllers in the Bold Venture 87 exercise. The questions to be answered should cover issues such as:

1. Are the proposed data collection elements available for collection in the Bold Venture exercise?

2. Does the measurement concept exclude important performance dimensions or factors which appeared to impact significantly on the outcome of the Bold Venture exercise?

3. Are the reports and data elements anticipated as available on JESS actually available?

4. How many observers with what, types of qualifications would have been required to collect the information identified in the performance measurement concept?

5. Is it possible to construct the planned battlefield event and staff action timelines based on the corps operations plan and other available data?

6. Does is seem feasible that a consise statement of the commander's intent and concept of the operation could be developed to serve as the basis for development of objective questions used to assess subordinate understanding of intent?

7. Does it appear to be feasible to interact with the exercise players in a manner that would allow collection of answers to questions regarding player understanding of the commander's intent and concept of the operation?

8. Is the data available on JESS to construct the actual battlefield event timeline called for in the measurement concept?

9. Does it seem feasible that observers could make the necessary observations to collect data to construct the actual staff action timeline called for in the measurement system?

10. Are there opportunities to insert probes into the exercise as it is currently structured and conducted?

While the list of questions above is certainly not exhaustive, it does provide an illustration of the type of information which should be collected to evaluation the feasibility of the measurement concept itself. If the data collected indicate that the measurement concept is viable, the necessary revisions to the concept suggested by the REDCOM observations should be made and a prototype version of the actual measurement system should be fully developed for implementation in the next REDCOM exercise using JESS (probably Bold Eagle 88). At this next exercise, the formative evaluation or phase two of the evaluation process should be implemented.

Formative Evaluation of the Performance Measurement System

During the formative evaluation of the measurement system, one segment of the research team should be devoted entirely to evaluation of the measurement system as opposed to collecting data using the system. The temptation usually exists to avoid using limited personnel assets for evaluation of the measurement system itself. Instead, the typical approach is to use the data collectors as the measurement system evaluation team. The problem with this latter approach is that data collectors often become highly involved in the data collection process and are unable to step back and objectively evalute the measurement svstem itself. As data collectors, their attention is focused on the evaluation of the performance of the organization thev are observing.

The general nature of the issues to be examined during a formative evaluation of a performance measurement system were noted previously. In the case of a corps performance measurment system, the following is a sample of the issues which should be carefully examined:

1. To what extent are copies of operations plans, reports, and other necessary documents needed for development of planned battlefield and staff action event timelines readily made available to the research team.

2. Are the probes inserted into the exercise simulation as planned? If not, what problems prevented their insertion?

3. Are the observers alerted as planned to the insertion of the probe?

4. Are observers able to make the observations of target staff elements as planned following the insertion of the probe?

5. Is it possible to acquire the snapshots of the battlefield situation from JESS as planned? What percentage of planned snapshots are collected? Is this an adequate number, too many, an appropriate amount? If problems exist in obtaining the snapshots, are they hardware, software, or controller cooperation problems?

6. Is it feasible to obtain selected hardcopy reports in the form of printouts from local workstations? Do the controllers operating the workstations consider this as a burden on their time? Are there too many printouts for their practical use of the data they contain?

7. Do the observers appear to influence the actions of the players in any adverse manner? Were their any player complaints concerning observers interfering with the corps staff operations?

8. Did the players, particularly the corps commander, consider the feedback given from the performance measurement system as useful?

9. Are the division commanders and principal corps staff officers available and willing to answer questions concerning their understanding of the corps commander's concept of the operation and intent? Should this be done verbally or with a short questionnaire? Are the players defensive? Do the players consider this to be interfering?

The process by which the data will be collected to conduct the formative evaluation of the measurement process includes three data collection techniques: observation, interviews, and surveys. The observations should be made by those members of the research team assigned to evaluation of the performance measurment system. These individuals will "float" throughout the exercise and observe and talk to data collectors, controllers, and to a limited extent, players in the exercise. Their attention should be focused on the actions of the controllers and data collectors, not the performance of the players. Two researchers will probably be adequate for performing this observation role. A major focus of this observation should be to evaluate procedures used by data collectors and problems they experience to identify the need for changes in observation guides and/or changes in the training of data collectors.

The second procedure for collecting formative evaluation data is through interviews. All data collectors should undergo an outprocessing interview at the end of the exercise. The interview should be partially structured with ample time left for each data collector to provide comments during an open-ended portion of the interview session. Topics to be covered during the structure portion of the interview should include the identification of problems and potential solutions in the following areas:

* Use of the observation guides

* Problems related to opportunities for observation

* Interactions with exercise players

* Interactions with exercise controllers

* Potential problems related to exercise interference

* Performance factors which are not currently captured which appear to be important

* Recommendations for changes in data collector training

In addition to the interviews with the data collectors a sample of exercise controllers should also be interviewed. The controllers selected for the interviews should be chosen from those individuals who had extensive interactions with data collectors or those who were involved in other procedures related to extracting data from JESS for the performance measurement system. The focus of the interviews with the controllers should be to determine the extent to which the performance measurement procedures or data collector actions were perceived as interfering with either the controller's job or the exercise itself. Efforts should be made to solicit controller suggestions for ways to improve the data collection process.

The final group of interviews should be conducted with a sample of players from the corps. The individuals selected for these interviews should include individuals who answered questions concerning their understanding of the corps commander's intent, individuals in staff elements under observation by the observers associated with the performance measurement process, and individuals who participated in feedback sessions based on the performance measurement system data. The interviews should be designed to obtain information concerning perceived interference by the measurement procedures or observers, suggestions for improving the data collection process, perceived utility of the feedback, and any concerns experienced by the players concerning the manner in which the performance data might be used by the Army.

The final methodology which might be used to collect data for the formative evaluation would be written surveys. The gains to be obtained from conducting a written survey will be determined by the size of the sample of controllers and players who are interviewed. If time or other factors limit the number of interviews to a relatively small sample of controllers and players with relevant information, then the expense of a mailed survey instrument may be justified. The survey instrument would cover many of the same topics mentioned in the discussion of the controller and player interviews. The written survev may also orovide a means to collect data from the controllers and plavers after they have had a chance to better evaluate their experience during the REDCOM exercise. Some change in perspective from the period immediately following the exercise to a time two or more weeks later is likely to occur, particularly for the individuals who were players in the exercise. Of particular importance would be changes in the players' perspecitives regarding the utility of the feedback received from the performance measurement system.

One note of caution which must be voiced concerning such a survey is that it is likely to have a relatively low return rate. This is likely to occur reqardless of the efforts made by the research team.

The data gathered from all of the sources should be summarized by issue and used to examine all relevant components of the corps performance measurement system. The suggestions for revision should be considered carefully. Particular attention should be paid to indications that any aspect of the performance measurement process interfered with the conduct of the exercise or the ability of exercise controllers to perform their jobs. Appropriate revisions to the performance measurement system should be made based upon the formative evaluation.

If the formative evaluation results in relatively minor changes to the performance measurement system, then performance data collected during the exercise may be used for the summative evaluation also. The summative evaluation which is the third phase of the evaluation process will be designed to begin with the same exercise as the formative evaluation. If the formative evaluation results in major revisions to the performance measurement system, the data collected for summative evaluation purposes will be disregarded and the summative evaluation will begin with the next exercise.

SUMMATIVE EVALUATION

As noted earlier, the summative evaluation of the performance measurement system represents what most researchers consider to be the validation of the measurement system. The six criteria which might be used in the summative evaluation of a corps performance measurement system were presented previously. As noted in the previous section, some of this data can be collected during the same exercise in which the formative evaluation is conducted. This is particularly true regarding the collection of data on player reactions to the feedback system. In fact, a written survey of all players receiving feedback from the performance measurement system is recommended for purposes of collecting data for summative evaluation purposes.

Data regarding the reliability of the performance measurements system can also be collected during the same exercise used for the formative evaluation. Two types of reliability data should be collected. The first type of data relates to the reliability of the event and outcome data generated by JESS. JESS is designed to allow restarting during the exercise itself. It can be anticipated that the computer system may "crash" at least once if not several times during the duration of an exercise. Such crashes of the system provide a means to examine the variablility (test-retest reliability) of the effects produced by the algorithms used in JESS. This examination of reliability is possible because the JESS will essentially restart from a period 0 to 30 minutes prior to the computer crash and replicate all commands entered by controllers into the system. Any variation in the status of units, etc. between the point at which the model crashed and the point at which it is ready to begin live play again should only be attributible to variation in the probablistic algorithms used to calculate casualties, weapon kills, and certain other outcomes in the model. It is anticipated that this variation should be relatively minor.

The second type of reliability to be examined in the corps performance measurement system is interrater reliability for observational data. The collection of such reliability data will require the use of multiple observers examining the same events. This interrater reliability data should be collected during both Bold Eagle 88 and the next REDCOM exercise. Adequate data should be gathered to test the interrater reliability of all major types of observation guides used in the performance measurement system. The analysis will be conducted using correlation coefficients to examine the degree of consistency in observer ratings, classifications, events recorded, etc. Average interrater reliabilitv coefficients should probably exceed .80 for most of the data collection instruments used. Lower interrater reliability coefficients may be a sign of poor observer training or vague or overly complex data collection and recording procedures.

The evaluation of the validity of the performance measurement system is likely to be extremely difficult. As noted earlier, the system contains multiple performance measures which should be correlated to indepent measures of corps performance outsided of the REDCOM exercise environment. Unfortunately, the major impetus for the development of the current corps performance measurement system is the recoanition of a lack of valid measures of corps performance. Therefore, it is unlikelv that a criterion-related validation strateav would be aporooriated for validatina the corps performance measurement system as a whole.

It may be possible to demonstrate at least internal validity of the performance measurement system bv examinina the correlations between different measures of performance generated by the svstem. This reoresents a construct validity approach to validating the performance measures. For example, the performance model presented in Figure 4-3 and knowledae gained from previous work with corps level oraanizations will allow one to predict that certain tvoes of relationshios should exist between different measures of corps performance. To the extent there is consensus amona knowledaable militarv SMEs reaardina the nature of these relationshios, one can examine the extent to which data generated by certain compenents of the performance measurement system are consistent with what is to be expected. The point of caution which must be voiced at this point is twofold. First, the "validitv" of this aporoach is deoendent on the extent to which the relationshios oostulated bv the SMEs are valid. Second, onlv certain measures of performance can be validated usina this process because it reauires multiple data points. Thus, correlations can be calculated only for measures of peformance which provided multiple data points during the exercise. Corps level summary measures of performance cannot be validated using this approach, although some of the raw data or subordinate measures of performance used to derive the summary measure may be candidates for validation.

As noted earlier, the most likely process for validating the corps performance measurement system will be through the content validation process. This will involve systematic evaluation by qualified SMEs. The SMEs must first examine the domain of critical performance factors representative of corps level organizations. After documenting this domain of tasks, functions, or performance dimensions, the SMEs must then examine the degree to which the corps performance measurement system adequately samples the domain. Judgments must be made as to the extent to which the measurement system adquately samples from the entire content domain of corps performance factors. Such a judgment may be quantified in a simplistic way such as indicating the percentage of the performance factors in the corps performance domain which are sampled by the measurement system. Concommitently, the SMEs must assess the extent to which the measurement system includes performance factors not relevant to the domain of corps performance. These factors represent sources of criterion contamination and should be removed from the system. More detailed procedures for conducting such content analyses are available in various publications in the areas of Industrial and Organizational Psychology.

Another criterion which can be applied to the evaluation of the corps performance measurement system is the extent to which there is variability among different units on the performance measures. For the corps level summary measures, this will require the collection of data across multiple REDCOM exercises and, therefore, will require considerable time. On the other hand, some of the raw performance data and some of the diagnostic process measures and selected engagement outcome measures will provide multiple data points in a single exercise. Adequate data to examine variability on these measures may be obtained from no more than two REDCOM exercises. The most appropriate measure of such variablility is likely to be calculation of the least squares measure of variance or standard deviation of scores on each performance measure.

The cost and ease of use of the corps performance measurement system can be assessed during the formative evaluation phase of the evaluation process. The cost factors to be considered in the corps performance measurement system are primarily related to the number of observers required and the types of skills required by the obervers. Costs of observer training and costs related to data storage, hardware (electronic clipboards), software (modifications in JESS), and development of observation guides tailored to each exercise must also be considered. Unfortunately, it may be extremely difficult to calculate cost savings or gains which will be obtained by application of the performance measurement system. This may preclude a quantitative cost-benefit analysis unless certain baseline assumptions regarding benefits can be made.

The final criterion measure which should be used to evaluate the corps performance measurement system is to determine the extent to which performance feedback impacts positively on subsequent performance of the corps. As currently structured, it will be very difficult to demonstrate positive impacts on corps performance within the context of the REDCOM exercise program. The corps is likely to receive feedback at the end of the exercise and by the time the corps participates in the next REDCOM exercise it is likely to have a new commander and have undergone a number of other changes which make it difficult to assess the impact of performance feedback. On the other hand, following the Bold Venture 87 exercise, all Army corps will be given the software and hardware to practice using the JESS in corps and division CPXs. It may be possible to construct appropriate research designs to examine the impact of a corps performance measurement system implemented within the context of repeated uses of JESS driven exercises within individual Army corps.

## Summary

The general conclusion which can be drawn regarding the validation of the corps performance measurment process is that it will be a difficult procedure which will require substantial time. While certain evidence regarding the utility and validity of the performance measurement system may be obtained in one or two runs of the REDCOM exercise system, much of this data will be relatively subjective in nature. More empirical validation evidence will require data collection across a number of exercises conducted by REDCOM and/or by individual Army corps.

It is also important to note that data from validation studies may produce more questions than answers. If the data indicate only limited evidence for the validity of the performance measures, a number of questions must be addressed. First, it should be recognized that validity is not a property inherent in a measurement instrument. The concept of validity involves the purpose for which data produced by the measurement instrument are to be used. For example, the measurement of a particular staff process may not be significantly related to measures of synchronization on the battlefield but may be moderately correlated to other staff actions that are related to synchronization. Putting aside the issue of determination of causality in correlational data, the issue of the validity of the measure of performance will depend on whether one is interested only in performance measures directly related to battle outcomes or in measures of performance which may indirectly impact on battle outcomes through their impact on other staff performance factors.

Furthermore, data indicating low correlations between measures may indicate any of a number of problems. If the exercise or simulation produces relatively little variation between units or across multiple runs with the same unit, it will be statistically impossible to demonstrate validity of the performance measures and the problem may be in the simulation; not the performance measurement system. If the simulation produces variation in performance but the measures do not appear to be sensitive to the performance variation then at least two possiblities exist. First, the measurement procedures may be inadequate and the performance factors may need to be operationalized in a different manner. Alternatively, it may be the case that the performance factor and model of performance developed in step three of developing the performance measurement system is inaccurate and new performance factors must be identified. The answers to such questions will not be directly provided by the validation data. Instead, they will require careful consideration of the validation data and other information by an experienced researcher with extensive knowledge of the performance measurement system and the nature of the organizational element and operations being assessed by the measurement system.

## REFERENCES


Bates, J. & Quinn, J. (1986). $T^2S = V$. U.S. Army Military Review, Mar, 21-31.

Bernardin, H. & Beatty, R. (1984). Performance appraisal: Assessing human behavior at work. Boston: Kent Publishing Company.

Cummings, L. & Schwab, D. (1973). Performance in organizations: Determinants & appraisals. Glenview, Ill: Scott, Foresman and Company.

Defensive Systems, Inc. (1984). HEAT executive summary. McLean, VA: Author.

DePuy, W. (1984). The case for synchronization: Toward a balanced doctrine. Army, November, 18-25.

DeVries, P. (1983). Maneuver and the operational level of war. U.S. Army Military Review, Feb, 14-34.

Doefel, J. (1982). The operational art of the Airland Battle. U.S. Army Military Review, May, 3-10.

Hall, W. (1986). A theoretical perspective of Airland Battle doctrine. U.S. Army Military Review, Mar, 32-43.

Headquarters, Department of the Army. (1984). Field manual 101-5: Staff organizations and operations. Washington, D.C.

Headquarters, Department of the Army. (1985). Professional development of officers study: Vol. 1. Washington, D.C.

Headquarters, Department of the Army. (1986). Field manual 100-5: Operations. Washington, D.C.

Hoyt, E. (1984). On to the Yalu. New York: Stein and Day.

Langley, M. (1979). Inchon landing: MacArthur's last triumph. New York: Times Books.

MacArthur, D. (1964). Reminiscences. New York: McGraw-Hill.

Maginnis, R. (1986). Harnessing Creativity. U.S. Army Military Review, Mar, 12-20.

Manchester, W. (1978). American Caesar. Boston: Little, Brown and Company.

McEnany, B. (1977). Uncertainties and inadequacies in theatre level combat analysis. Paper delivered at 16th U.S. Army Operations Research Symposium, 12-14 Oct, 1977.

McGee, M. (1985). Battle staff integration. Exel net concept paper. (Number 28-85). Fort McPherson, GA.

Olmstead, J., Baranick, M. & Elder, B. (1978). Research on training for brigade command groups: Factors contributing to unit combat readiness. (Technical Report No. FR-ED(C)-78- 1). Alexandria, VA: Human Resources Research Organization.

Olmstead, J., Cristensen, H. & Lackey, L. (1973). Components of organizational competance: Test of a conceptual framework. (Technical Report No. 73-19). Alexandria, VA: Human Resources Research Organization.

Olmstead, J., Elder, B. & Forsythe, J. (1978). Organizational process and combat readiness: Feasibility of training organizational effectiveness staff officers to assess command group performance. (Report No. 468). Alexandria, VA: Army Research Institute.

Peden, I. & Barth, D. (1985). Final report of the 1985 summer study on training and training technology-applications for Airland Battle and future concepts. Washington, D.C: Army Science Board.

Richardson, W. (1986). FM 100-5: The Airland Battle in 1986. U.S. Army Military Review, Mar, 4-11.

Schein, E. (1972). Organizational Psychology. (2nd ed.). Englewood Cliffs, NJ: Prentice Hall, Inc.

Sheldon, W. (1968). Hell or high water: MacArthur's landing at Inchon. New York: Macmillan Company.

U.S. Army Command And General Staff College. (1984). Field Circular 100-15: Corps Operations. Fort Leavenworth, KS.

U.S. Army Command And General Staff College. (1985). Field Circular 101-55: Corps and Division Command and Control. Fort Leavenworth, KS.

U.S. General Accounting Office. (1985). Army training: Need for a lessons learned system at the Army's National Training Center. (Pre-Publication Copy). Washington, DC: Author.

U.S. Army Research Institute. (1986). The Army Research Institute Plan for an NTC-based Research Program. Alexandria, VA: Author.

Wass de Czege, H. & Holder, L. (1982). The new FM 100-5. U.S. Army Military Review, Jul, 53-70.

Wood, J. (1982). Very grave suspicion. Royal United Services Institute Journal, Mar, 1982.

## APPENDIX A

## QUESTIONS USED IN REDCOM INTERVIEWS

1. Structure of Bold Venture 87 Exercise

   - Exact dates for JTLs play
   - Exact dates for play with JESS
   - Army units involved
   - Air Force Units involved
   - Schedule of key exercise (not scenario) events
   - Location of all players and controllers
   - Debriefing/ After Action Review Sessions
   - Interplay between JTLs and JESS
   - Ideally, would like operations plan for exercise
   - How similar will future JWC exercises be to Bold Venture 87? How will they differ?

2. Exercise Scenario

   - Ideally, would have copy of scenario
   - Need enough detail to identify potential probe events
   - Need overview and background of the scenario if we cannot obtain a complete copy
   - Copies of messages generated by JTLs and JESS which are used to drive the exercise

3. Senior Controller Functions

   - Who will act as Senior Controller?
   - Written description of role if available
   - How does the Senior Controller and his staff relay information to players?

- Who controls the senior controller? Or is he "God"?
- What is the degree of potential influence of activities and outcomes exercised by the senior controller?
- What is the relationship (during the exercise) of the senior controller and the Corps Commander?
- What is the relationship of the senior controller and the Joint Task Force Commander?
- How accurately do controller/players provide appropriate information to players during the exercise?
- What is the senior controller's role in the real world vs. in the exercise?
- Controller/Interfacers vs. Controller/Players?
- What is the relationship of the senior controller and and the OPFOR?
- Does the OPFOR have access to all information?
- What training for role does the senior controller currently receive?
- What data collection or recording is done by the senior controller or his staff?
- What is the primary focus of the senior controller's attention?
- What is the senior controller's role in AARs?

4. Opportunities for Observation by ARI Data Collectors

- Where are the nodes that observers could be placed?
- Who (rank, specialties, etc.) will act as observers for REDCOM? How many?
- From what REDCOM element (J-3, JWC, or J-5) are the observers coming?
- Where will REDCOM observers be placed?
- Will the Army and Air Force units in the exercise have additional observers? Who? How many? Where?

- What Corps staff elements will be observed most closely by REDCOM?

- Will REDCOM observers have any checklists, data collection forms, etc.?

- Is REDCOM providing any training for their observers?

- Are there any particular events in the scenario that are being used to focus observer attentions (probes)?

5. Potential Probe Events

- How could/would probe events be implemented?

- Are any probe events currently planned?

- How could observers be alerted to occurrence of the probe?

- Can probe events be recorded and activities generated by the probe tracked automatically by JESS?

6. Operation of JESS as an Exercise Driver

- Sample messages, screen displays, etc.

- What is the interface between JESS and JTLs?

- What tracking capabilities and data extraction capabilities exist in JESS to allow tracking of player activities?

- What data if any will be extracted and saved from the exercise run as currently planned?

- What medium, if any, can be used for saving data from JESS?

- Exactly how are player responses entered into JESS?

- What is lag time between a response by a player such as preparing an order or message and the time that response enters the computer system and is recorded by JESS? How close to real-time?

- Are responses tagged to specific players (corps staff elements) or to controllers who enter response on the system?

- Do input restrictions for JESS limit player actions or creativity in any way?

- Is it possible to extract intermediate performance indicators from JESS? These are major actions such as movement of Divisions, execution of air strikes, etc.

- How will the interface between the Army and Air Force be played in JESS?

- What is current assessment of validity of battle outcomes generated by JESS?

- Is it possible to re-establish a sequence of orders and commands in JESS? For how long?

- Is the role of JESS to generate exercise realism or battle outcomes? Which is primary?

7. Role of JTLs and its Interface with JESS

- How is JTLs being used for the build up for Bold Venture 87?

- What is the corps player involvement in the pre-exercise build up phase? Why?

- What players from the participating corps are involved?

- How do JESS and JTLs interface with respect to the architecture of the two models?

- How are the JTLs and JESS databases related or linked?

- How different are the algorithms used in JTLs and JESS to produce battle outcomes?

- Is JTLs used strictly to provide Intelligence situation development?

- Are players allowed to impact on situations in JTLs, i.e., are they moving and fighting maneuver elements?

## APPENDIX B

## REVIEW OF PERFORMANCE MEASUREMENT SYSTEMS

### General

The review of the performance measurement literature indicates that the information processing model of corps performance is consistent with the models used in previous attempts to measure performance of commanders and their staffs. The review of existing measurement systems developed to assess performance of Army staffs provides evidence supporting the information processing approach adopted in the current effort. The review also identifies a number of problems which must be avoided in development of the current performance measurement system.

### FORGE Research Program

A number of research studies have been conducted examining unit performance. Many of these studies have focused on evaluation of performance at the battalion level. One group of studies particularly relevant to the current effort is a series of studies which are commonly labeled as the FORGE research studies. This research was conducted by Olmstead and his associates (Olmstead, Christensen, and Lackey, 1973; Olmstead, Baranick, and Elder, 1978; Olmstead, Elder, and Forsyth, 1978) in the 1970's. The research focused on the measurement of information processing of battalion staffs and the impact of organizational processes on battalion performance in combat simulation exercises.

The information processing model used by Olmstead is based on seven processes derived from Schein's (1972) organizational Adaptive Coping Cycle. These seven organizational processes and their definitions are presented in Table B-1. The seven organizational processes were assumed to be related to the organizational competence of a battalion. Organizational competence is defined in terms of three components which Olmstead, Elder, and Forsyth (1978) defined as:

Reality Testing. Capacity to assess the reality of situations facing the organization -- the ability of the organization to search out, accurately perceive, and correctly interpret the properties and characteristics of

**TABLE B-1. DEFINITIONS OF ORGANIZATIONAL PROCESSES**

| | |
|---|---|
| Sensing | The process by which an organization acquires and processes information about its internal and external environments. |
| Communicating Information | The process of transmitting information that is sensed to those parts of the organization that can act upon it. |
| Decision - Making | The process of making decisions concerning actions to be taken as the result of sensed information. |
| Stabalizing | The process of taking actions to adjust internal functioning and maintain organizational stability and integration that might otherwise be disrupted as a consequence of actions taken to cope with changes in the organization's environments. |
| Communicating Implementation | The process of transmitting decisions and decisions-related orders and instructions to those parts of the organization that must implement them. |
| Coping Actions | The process of executing actions intended to cope with changes in the organization's environments. |
| Feedback | The process of evaluating the results of a prior action through futher sensing of the external and/or internal environments. |

its environments (both external and internal), particularly properties that have relevance for the objectives and survival of the organization.

Adaptability. The capacity of the organization to solve problems arising from changing environmental demands and to act with effective flexibility in response to these changing demands.

Integration. The maintenance of structure and internal functions under change and stress, and a state of relations among sub-units that insures that coordination is maintained and sub-units do not work at cross purposes.

In one of the later studies conducted as part of this programatic research effort, a measurement system based on the adaptive coping cycle model was used to examine the relationship between battalion information processing effectiveness and battalion performance. The study was performed as part of the Cardinal Point II exercises conducted in July to August in 1978. The measurements were obtained during the battle simulation phase of the Cardinal Point II exercises using the PEGASUS simulation.

Olmstead, et.al. used trained Organizational Effectiveness Staff Officers to make subjective ratings on measures of each of the seven process dimensions defined in Table B-1. The observers provided ratings on a single four point scale for each of the seven dimensions. The OE staff officer ratings on the seven organizational process measures were then correlated with controller ratings of battalion effectiveness during the PEGASUS simulation. Olmstead, et. al. found highly significant correlations between the ratings on organizational process measures and ratings of battalion effectiveness in the simulation.

While the significant correlations obtained by Olmstead, et. al. suggest that an information processing model of battalion effectiveness has utility, several notes of caution must be voiced. First, all of the measures used in the study were highly subjective in nature. Second, the nature of the simulation provided little opportunity for factors other than information processing to impact on combat outcomes. Finally, the measures used by Olmstead and his associates provide relatively little objective feedback. The feedback provided to the units in the FORGE research was highly qualitative in nature and any positive impacts produced by the feedback probably reflected the skills of the trained OE officers as much or more than the strengths of the measurement system itself.

While the FORGE research methodology can be criticized for the reasons cited above, there has been renewed interest in this research in the recent years (McGee, 1985). This interest was sparked by observations of battalion performance at the National Training Center. The observations have been interpreted as supportive of the findings from the FORGE research and prompted action to develop new measures of "battle staff integration." While the current concept has been labeled as battle staff integration, it reflects essentially the same organizational process model used by Olmstead et.al. (1978).

HEAT Methodology

An information processing model of command and staff performance at an organizational level closer to corps was developed by Defense Systems, Inc (1978) in a project examining ithe appropriate size for theater level headquarters. In early stages of the project, it was recognized that there was a lack of theory and measurement procedures for assessing the effectiveness of theater level headquarters elements.

The performance model which evolved in the theater level headquarters research effort is essentially an information processing model. The headquarters element was "regarded as analogous to an adaptive control system where control is exercised through planning and execution cycles." The model focuses on the information processing, planning, and decision making functions of headquarters elements as well as the manner in which the headquarters element is structured.

The measurement system developed for use in the study of the theater level headquarters is labeled The Headquarters Effectiveness Assessment Tool (HEAT). This system is commonly referred to as the HEAT methodology. The methodology attempts to assess the quality of seven organizational processes which are listed and defined in Table B-2.

The quality of the organizational processes is assessed by completing 12 data forms which require ratings on the quality of various reports, briefings, messages, etc. produced by the headquarters element as well as observations of the headquarters staff during planning and execution phases of an exercise. Figure B-1 illustrates the steps involved in implementing the HEAT methodology.

The organizational process measures derived from the ratings of quality of the six phases of the headquarters

| TABLE B-2. HEAT METHODOLOGY PROCESSES | |
|---|---|
| Monitor | The headquarters must obtain raw data concerning those aspects of the environment that it wishes to control. The quality of monitoring can be measured by directly comparing the perceptions in the headquarters (HQ) to reality. A secondary measure is the age of the information available to the headquarters. |
| Understand | The headquarters processes the available information to produce an understanding of the situation, i.e., a set of hypotheses about what can be going on now and in the immediate future. The best understanding is one in which the primary hypothesis - the one considered most likely - is a reasonable approximation of reality. The quality of understanding can be assessed by measuring the correctness of this set of hypotheses. |
| Alternative Actions | The headquarters develops alternatives specifying what can be done to alter the situation understood to exist. The quality of alternatives can be measured by:<br>1) their completeness<br>2) their number |
| Prediction | For each alternative action considered, the HQ makes a prediction about consequences. This includes at least two elements:<br>1) whether the material/force assets exist or can be assembled to carry out the alternative<br>2) what the enemy's response to it will be.<br>Predictions can be evaluated by determining their completeness and the correctness of those predictions adopted. |

| TABLE B-2. HEAT METHODOLOGY PROCESSES, CONT. | |
|---|---|
| Decisions | Decisions are made on the basis of the predictions. There are no direct measures of decision quality in the HEAT system. However, decisions always take the form of a plan to be implemented, specifying missions, operating boundaries, assets, and a timetable for subordinate forces. |
| Direction | Plans are communicated to the appropriate organizations in the form of some directive. The correctness of directives can be assessed by examining the extent to which the decision and plan are correctly stated. |
| Interaction With the Environment | Other important diagnostic measure focus on the non-effectiveness processes by which the HQ interacts with its environment - - inquiries and reports. The quality of these processes can be measured by:<br>1) the timeliness of inquiries made by the HQ based on the age of the information it is monitoring<br>2) the clarity and completeness of its direction to subordinates based on their inquiries seeking information, clarification, and addition<br>3) the quality of the reports the HQ produces |

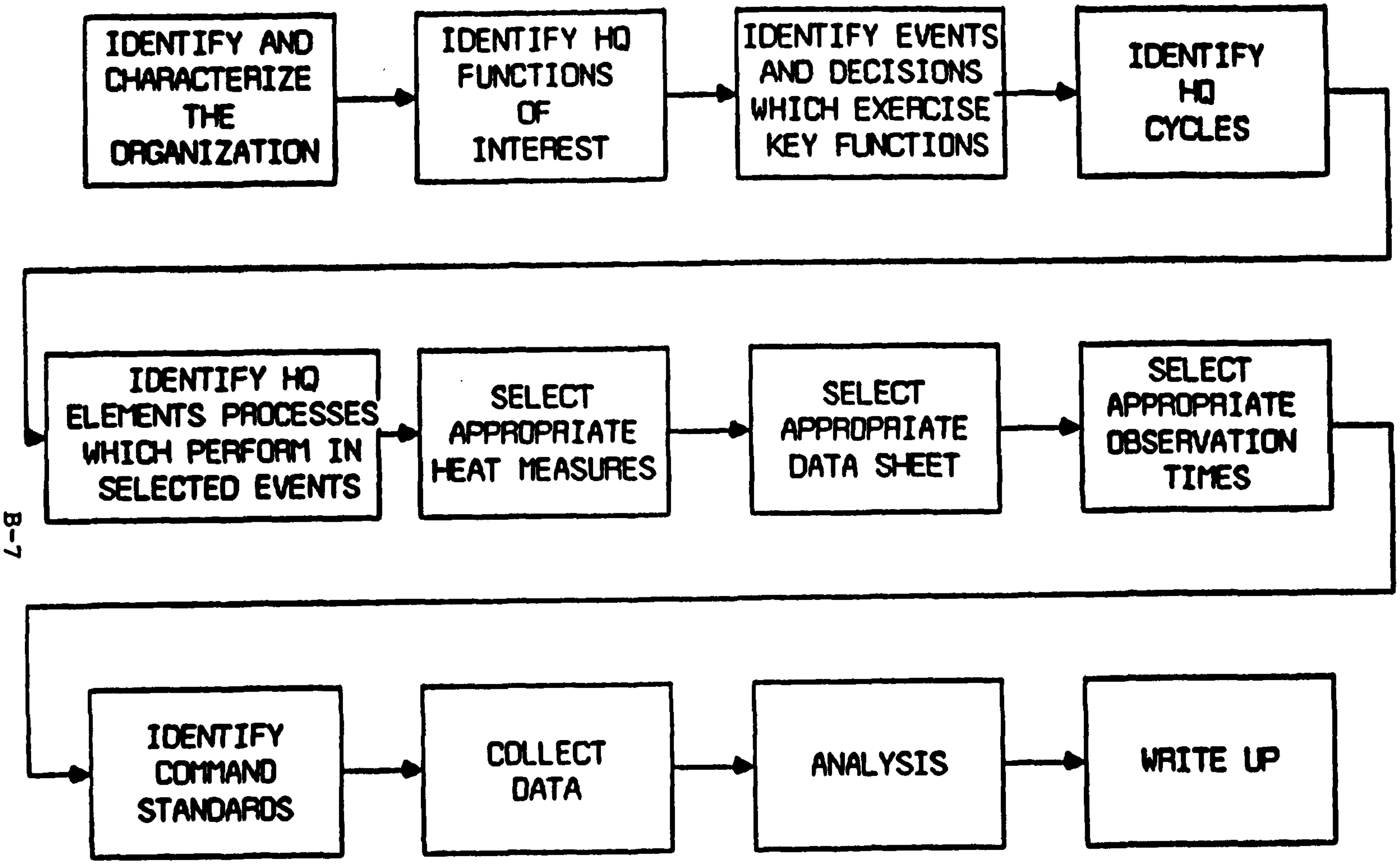



FIGURE B-1. Heat Methodology Steps

operation cycle are supplemented by various effectiveness ratings. Unfortunately, the effectiveness ratings used in the methodology are also relatively subjective judgments as to the quality of plans produced by the headquarters element. Also, like the measurement procedures used in the FORGE research, the system focuses primarily on process rather than outcome oriented measurement.

While the HEAT methodology suffers from many of the same problems as the FORGE research measurement methodology, it does have a number of strengths. First, as is suggested in Figure B- 1, the system provides an opportunity for some tailoring the measurement system to the particular exercise and unit being evaluated. This feature is essential at the corps level and above because of the relatively unique missions and structures of each organization. Furthermore, the system does provide a pool of potential observation items for various elements found in higher level headquarters. While a process oriented system is not sufficient for a corps performance measurements system, it is one essential component of the system and like the FORGE research measurement system, is focused on the battalion level. However, it is focused on outcome rather than process measurement. The underlying model for the NTC measurement system is illustrated in Figure B-2.

The NTC performance measurement system is being developed primarily for the purpose of providing training feedback and research data for lessons learned development. The feedback will be based upon a backward audit trail concept which begins with measures of unit performance effectiveness. These effectiveness measures are developed from bottom line combat outcome data. The particular outcome measures and weights assigned to each measure depend on the particular type of mission being conducted by the battalion task force. In addition to the bottom line feedback, information will be provided on how well the battalion and its subordinate elements performed mission critical tasks.

Supplementing the performance measures described above will be observational data provided by trained observer controllers and a highly objective graphic representation of the actual battlefield events which occurred throughout the entire mission. This latter feedback is made possible through the highly sophisticated instrumentation system at the NTC. This instrumentation system makes it possible to literally replay a history tape which provides positions and firing data of all major weapon systems during the entire mission. As part of the after action review of each mission, a short summary tape of key events is extracted

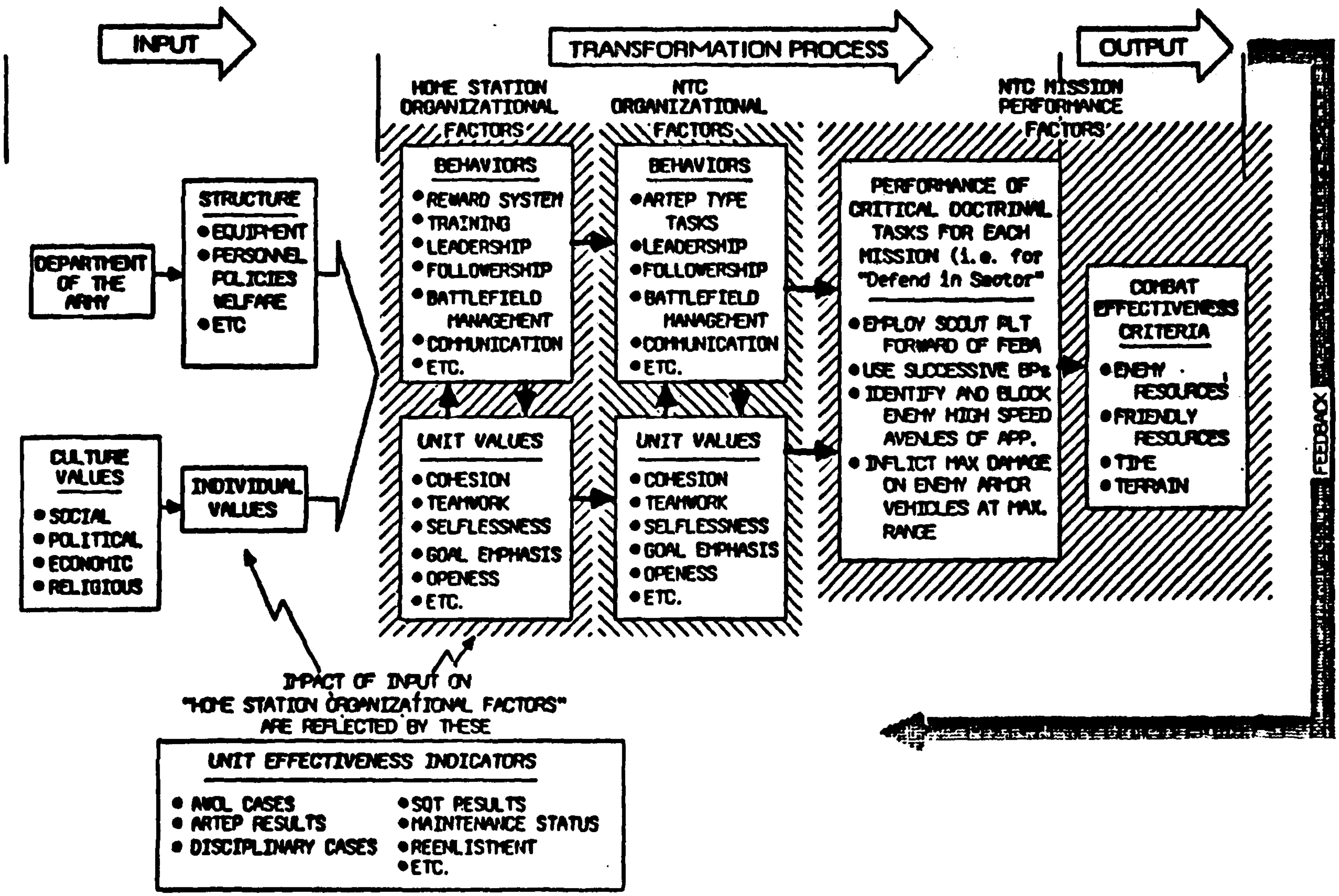



FIGURE B-2. NTC Unit Combat Effectiveness Model from the mission history tape and replayed at the beginning of the review session. This tape and the data and observations made by observers provides a highly effective vehicle for providing training feedback.

As might be ascertained from the brief description of the NTC performance measurement system, it is considerably more objective than either the measures used in the FORGE research or the HEAT methodology. This is possible, in part, because the environment and instrumentation system at the NTC provide very realistic combat conditions and highly objective casualty and battle damage assessment data. It should be noted, however, that the performance model and measurement concepts used to develop the unit effectiveness and critical task performance measurement systems were primarily outcome rather than process oriented.

The three performance measurement systems described above represent behavioral science approaches to examining the performance of a unit or organization. Each of the approaches involves collecting data from an actual organization or unit engaged in a training exercise or operational mission. A second, radically different approach for examining performance of a corps organization should be addressed at least briefly. The approach referred to is a modeling approach. A variety of combat simulation models exist which are designed to model the actions and outcomes of various organizational elements with different configurations, different weapons systems, under conditions of various force ratios, etc. These models produce a variety of combat outcome data related to casualties suffered, casualties inflicted, equipment losses, etc. The models have been used for a variety of purposes including evaluation and development of doctrinal concepts. The models have particular appeal in examining the performance of large units because it is extremely difficult to conduct realistic maneuvers with corps and larger elements.

As noted by DePuy (1984) and others (McEnany, 1977; Wood, 1982) extreme caution must be used in applying such models to predict the performance capabilities of actual units. For the most part, such combat models reflect only the effects of weapons systems and other physical effects with little or no input reflecting the human element of combat. Furthermore, such models provide limited means for a commander to assess the effectiveness of his actual organization. For these reasons, it is assumed that combat models alone do not provide a viable alternative for producing corps measures of performance. On the other hand, the use of such combat models as part of corps level exercises is assumed to be an essential element in the current measurement system. Furthermore, the models will provide some outcome measures which represent one source of criterion data to be used in the corps performance measurement system.

The review of the performance measurement literature and examination of each of the four measurement approaches briefly described above suggests several conclusions. First, there is evidence that information processing models of command and staff performance may be related to effective performance of combat units. Second, while information process measures may be important, process-oriented measurement systems tend to produce highly subjective data which is not outcome-oriented. Third, a performance measurement system resembling that under development for the NTC has more potential for acceptability and utility than a performance measurement system which is primarily process oriented.

Another lesson learned by the present authors from work conducted at the NTC which is not discussed above is that simply having large amounts of objective data does not ensure that commanders and their staff will receive effective feedback. In fact, work at the NTC indicates that an effective performance measurement system must be developed based on some model of unit performance rather than developed inductively by aggregating large amounts of unrelated data which has been collected simply because an instrumentation system made it feasible to collect.

The review of the performance measurement literature also suggests that extreme caution must be exercised in using combat outcome measures generated by combat models. This finding reinforces the warning voiced earlier concerning the use of bottom line combat outcome measures as the primary criterion measure for assessing corps level performance.

APPENDIX C

# THE REDCOM JOINT EXERCISE PROGRAM

## General

As noted earlier, one assumption made in the development of the corps performance measurement system is that the system will be implemented in the context of joint exercises conducted by REDCOM. To understand the nature of the performance measurement system and the validation plan for the system, the reader must have a basic understanding of the manner in which the joint exercises at REDCOM are structured and conducted. This section of the report provides an overview of the structure and procedures evolving for the joint exercises which will be conducted by REDCOM.

## Structure of a joint REDCOM Exercise

Figure C-1 provides a schematic of the key components contained in a REDCOM exercise. The major components consist of the exercise players, the Joint Exercise Support System (JESS), The Joint Theater Level Simulation (JTLS), the exercise controllers, the OPFOR controllers, and a senior exercise control element. Each of the major components and the relationships between the components is described briefly in the paragraphs which follow.

## Exercise Players

All of the exercises conducted by REDCOM are designed as joint exercises. Of particular interest to the current effort are the Bold Venture and Bold Eagle exercises. Bold Venture is a joint Army - Air Force exercise while Bold Eagle is a joint Army - Navy exercise. The Bold Venture exercise is also strictly a CPX while Bold Eagle has both CPX and FTX components. In both exercises, the Army element participating in the CPX will be a corps-size organization. Beginning with the Bold Eagle 88 exercise, the REDCOM exercises should include play from a complete echelon above corps (EAC) element. This echelon will be represented by a Joint Task Force organization commanded by a four star general.

On the Army side of the house, the exercises are designed to allow participation of all members of the corps and division staff including the corps and division commanders. The brigade commanders and staff function in a player-controller role in these exercises. The division and

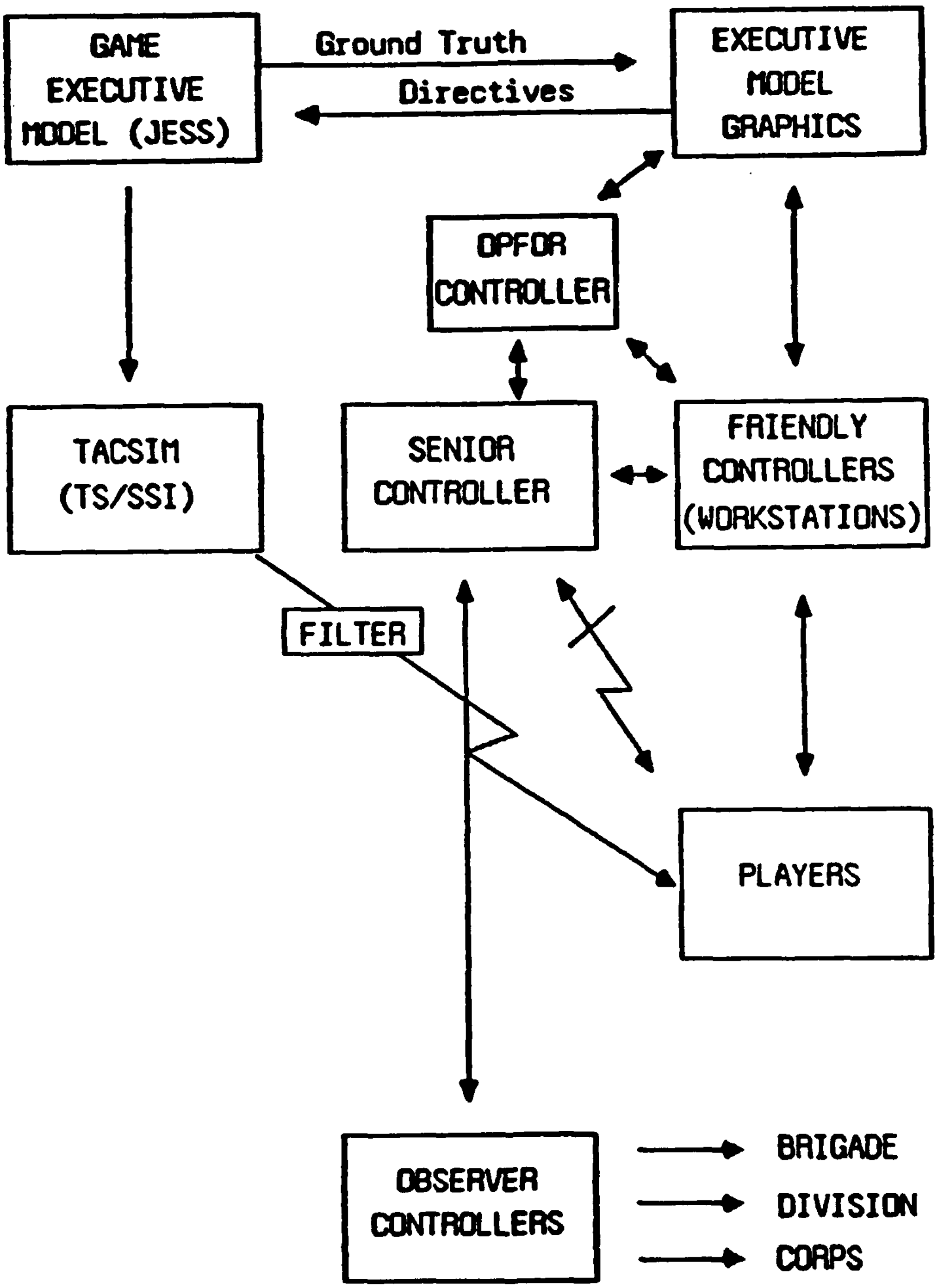



FIGURE C-1. REDCOM Exercise System

corps staff function in their normal manner and the vast majority of these players have no direct interface with JESS, the computer model driving the exercise. In fact, the workstations are located in a centralized building with most of the division and corps players deployed in the field in distributed CPs.

The JESS is designed to enable divisions to participate in the REDCOM exercises while remaining at their home-station locations. This distributed exercise system will be tested in Bold Venture 87. Assuming that the test proves successful, future exercises will be designed to include more players in a cost effective manner.

The role of the Air Force will be played by a small number of Air Force controllers in Bold Venture 87. In subsequent exercises, however, the Tactical Air Command (TAC) or other Air Force elements will provide players at appropriate organizational levels. The use of a distributed exercise system will contribute to increased participation of the Air Force in future exercises.

## JESS: Overview of the System

JESS is a computerized battle simulation system. It might best be thought of as a computerized battle board that eliminates the need for manual movement of game pieces on map boards. It also provides automatic calculation of a variety of battle outcome data which were previously calculated manually by controllers. The reader should be cautioned, however, that JESS is designed primarily as an exercise driver. JESS is not a model with extensive analytic or predictive modeling capabilities. JESS is currently in the developmental phase and its refinement will continue through at least 1989 or 1990.

At the present time, there is no performance measurement feedback system built into JESS. While JESS generates substantial amounts of data which could serve as part of a performance measurement system, the information is not currently saved by the system. A performance measurement capability on the JESS is planned for the future. The performance measurement concepts developed in this research effort may serve as the basis for the development of this performance feedback system.

The JESS is run on a network of mini- and microcomputers with a central processing unit actually running the simulation program. The system includes approximately 30 to 40 work stations for a joint exercise including an Army Corps and appropriate Air Force and/or Naval units. Each work station consists of:

- Two CRT (VT 220) terminals for entering and displaying commands and reports
- A large color graphics monitor for display of unit locations on terrain maps and unit status displays
- A printer for obtaining hard-copy printouts of reports

The JESS work stations are typically distributed in the following manner:

1. At corps level:

   - A corps fire support station for corps artillery
   - A corps combat support station representing non-divisional assets except those of the Corps Support Command (COSCOM)
   - A corps admin/log station representing COSCOM units

2. At division level:

   - Brigade stations representing Bde HQs and maneuver battalions
   - A division fire support station for division artillery
   - A division combat support station for non-DISCOM division support units
   - A division admin/log station for DISCOM elements

3. BLUEFOR Air:

   - Work stations for Blue tactical air control

4. For OPFOR controllers:

   - Maneuver and fire support work stations
   - A tactical air work station
   - A control/log work station

5. To assist in overall control of the exercise

   - A theater logistics workstation

   - A Blue ground forces master control station manned by REDCOM exercise controllers

   - A Blue tactical air master control station manned by REDCOM exercise controllers

   - A technical master control station manned by JPL computer science personnel

<u>Exercise Controllers</u>

Each JESS workstation is manned by a team of controllers which may vary in size from 7 to more than 50 individuals idepending on the function of the workstation. For example, a brigade work station is typically manned by a minimum of 8 individuals with the following composition:

- Team Chief
- Operations controller
- Intelligence controller
- Fire support controller
- Administrative/logistics controller
- Non-Commissioned Officer assistant
- Air Liaison controller

Certain workstations such as the division and corps fire support and admin/log stations may be manned by considerably larger teams.

The controllers at each workstation interface with JESS by entering commands from a variety of menu screens used to perform various functions. Functions which may be performed at each workstation vary with the type of workstation. At brigade workstations which control the maneuver battalions, controllers may enter commands to move units, change the task organization of units under their control, call for fire support missions, lay minefields, breach minefields, change air defense postures of their units, and perform other functions related to control of tactical units at the battalion level. With the exception of the controllers at the master control stations, the controllers at each workstation can enter commands which affect only the units under the control of the particular workstation that they operate. For example, the controllers at a brigade work station can control the movement of only the maneuver elements organic to and attached to the particular brigade they represent.

## Player Interface with the JESS

The controllers at the JESS workstations play a much more important role that that of simply entering commands on a CRT. The workstation controllers are the primary interface between the players in the REDCOM exercise and the JESS. The controllers function as role players who translate information displayed on the graphics monitors and CRTs of the JESS workstation into the type of information which would normally be available to commanders and their staffs at the division and corps levels.

The role playing demands become readily apparent when one realizes that all controllers at workstations can see the locations of all units (BLUE and RED) involved in the entire operation. In other words, the controllers at the work stations have perfect information. The burden of judging the amount of information and timing for release of information available on JESS to the players falls on the controllers. In effect, the controllers are the filter and interface mechanisms between the computer and the players in the REDCOM exercise. The primary job of the controller is to make the JESS as transparent as possible to the players. A good example of the type of role playing which imust be performed can be illustrated by a brief discussion of the types of problems which may arise in movement of units.

The JESS represents terrain using a hex system. The distance represented from the center of one hex to the center of adjacent hexes is 3 kilometers. All roads, rivers, and similar terrain features are imposed on this hex terrain model using straight lines which run on the perimeter of the hex or from the hex centers to the sides of the hex. Because the JESS uses a hex system for terrain representation, the exact location of roads, etc. in JESS does not match the coordinates which the units have for such features on their maps.

This hex representation system creates situations such as the following. A division commander may order a brigade commander to locate a battalion at a specific set of coordinates which would place the battalion on the north side of a terrain feature such as a river. If the controller moves the unit to those specific coordinates, JESS may locate the battalion on the south side of the river because of the location of the river as represented in the hex system. It is the controller's responsibility to recognize that the commander wants the battalion on the north side of the river. Furthermore, in addition to making the appropriate correction in the location of the unit in

JESS, the controller must also remember to make a translation in coordinates when reporting the location of the unit back to the division commander, G-3, or other appropriate personnel.

## The Joint Theater Level Simulation (JTLS) System

A second simulation system which may be incorporated in future REDCOM exercises is JTLS. This simulation is very similar in structure to JESS but is designed for modeling at the theater level. One aspect of Bold Venture 87 is an examination of the use of JTLS as a means of developing the situation for the starting point of the exercise using JESS. That is, data relevant to the scenario used in JESS will be loaded into JTLS and that model will be run for a period of several weeks. In the future, players from the Army and Air Force units participating in the JESS-based exercise would man the JTLs workstations and be actively involved in the evolving combat situation. The involvement in JTLS would provide a realistic background for the start of the JESS based exercise rather than the "cold start" which currently occurs in typical CPXs.

At the current time, JTLS does not interface directly with the JESS. Plans exist for developing software to allow such an interface, but the completion date for this work is unknown. Also, it should be noted that for the Bold Venture 87 test of JTLS for situation development for JESS, no players from the units participating in the JESS exercise are actively involved in the JTLS play. REDCOM is providing all of the controllers used in the JTLS run for Bold Venture 87.

## Senior Controller Element

Perhaps the most critical component in the REDCOM exercise structure is the senior control element. This element is actually composed of a number individuals performing four different functions. The deputy commander of REDCOM plays the role of assistant director of the REDCOM exercise and functions as the primary interface between REDCOM and the Army Corps Commander and other exercise players. In this sense, he plays the role of the senior controller for the entire exercise. As assistant director of the exercise, he attends all major briefings of the REDCOM controllers as well as all major briefings held by the corps commander and other exercise players. The combined player and controller perspectives provide this individual with the knowledge required to direct changes which may be needed to obtain the desired exercise objectives. For example, it would be this individual who would direct the OPFOR controllers to take a particular course of action designed to present a specific battlefield situation for the Army Corps Commander and/or the Air Force or Navy commander.

The assistant director of the REDCOM exercise is also the individual who currently provides feedback to the corps commander and his staff. The feedback is delivered during a "hot wash" following the completion of the exercise. This "hot wash" is an executive session conducted at the general officer level. The actions taken by the assistant director of the REDCOM exercise provide him with the unique perspective required to conduct this executive level feedback session.

The second function of the senior controller element in the REDCOM exercises is performed by the chief of the REDCOM J-3 exercise control branch (J-3 - EC). The colonel who performs this function has the responsibility for keeping the exercise going. He is in charge of all controllers for the exercise and is the primary trouble-shooter for the exercise. Prior to the exercise, he oversees the selection and assignment of REDCOM exercise controllers and the development and implementation of training for controllers assigned to the exercise by agencies outside of REDCOM. Once the exercise begins, he settles questions concerning controller decisions, handles problems with exercise support logistics, and solves other problems which may potentially interfere with successful completion of the exercise.

A third component of the senior controller element in the REDCOM exercise is represented by the officers manning the ground and air master control workstations for the Blue Force. These individuals represent the senior controllers for the JESS. The workstations manned by these officers have the capability to make adjustments to the JESS such as movement and resupply of all of the Blue Force elements included in the model. These officers use the master control workstations to correct problems in the JESS that might produce unrealistic effects in the exercise. For example, the current version of JESS will not allow two combat effective, opposing units to occupy the same hex. Furthermore, iit does not make any difference whether the units vary considerably in terms of size and composition. Until one of the units has been attritted below a certain threshold value, the second unit can not enter the hex previously occupied by the first unit. An instance in which this may produce unrealistic effects is when a small force, perhaps a dismounted infantry company or platoon occupies a choke-point and is being opposed by an armor brigade or division on a high-speed avenue of approach. In reality, the platoon or company would be quickly overrun if it did not have an extensive network of obstacles and/or effective antitank weapons. The nature of the model used in JESS, might allow the company or platoon to delay the division for an inordinate amount of time. The individuals manning the master control workstations can take appropriate actions to correct this situation before it creates unrealistic effects in the exercise.

The general guidelines followed by the officers manning the master control workstations call for minimum interference in the free-play nature of the exercise. As illustrated by the example above, their role is not to affect the outcome of the exercise, rather, it is to avoid or correct any potentially unrealistic effects created by peculiarities of the JESS. These officers provide feedback to JPL, the developer of JESS, and to appropriate authorities in REDCOM concerning the problems they observer and any potential solutions they have evolved for correcting such problems.

The final component in the senior control element of the exercise is represented by the civilian technicians who man the master technical workstation. These individuals work for JPL and provide the technical control over the JESS. The primary function of this group of individuals is to prevent and/or quickly solve any technical problems with JESS which would cause the computer system to "crash."

## The OPFOR Controllers

The final major component in the REDCOM exercise structure illustrated in Figure C-1 is the OPFOR controller element. This element consists of approximately 50-60 players commanded by a colonel. The OPFOR controllers are trained in red doctrine and man the OPFOR air and ground workstations. The OPFOR controllers work closely with the REDCOM controller element to create the appropriate battlefield context. However, it should be noted that much of the OPFOR play in the REDCOM exercise represents the free play efforts of the senior OPFOR controller.

## Exercise Process

The coordination of all of the exercise components and the thousands of players and controllers participating in a REDCOM exercise is a major undertaking requiring detailed planning. Various elements within REDCOM are involved in the planning and execution of each joint exercise. The REDCOM J-3 element develops a five year exercise plan which identifies the major iexercises to be developed and conducted by REDCOM. Approximately one year prior to the scheduled date for an exercise, project officers (LTCs) are assigned to oversee the development of the exercise. The officers work with the REDCOM command element and elements in the services participating in the exercise to establish the exercise objectives. After objectives have been established, the project officers focus their attention on arranging the participation of appropriate players from each service and other exercise logistics.

The REDCOM J-2 element in conjunction with the REDCOM J-3 element works to produce the overall exercise scenario. This scenario will be presented to the exercise players in the form of a Theater level operations plan. The scenario also drives the development of the OPFOR operations plan and the development of the database to be loaded into the JESS.

The theater level operations plan is delivered to the senior commander of each of the player elements from the participating services several months prior to the actual exercise. Each service element then prepares operations plans for their organi-zation. Members from the REDCOM exercise control branch in the REDCOM J-3 element work with the exercise participants in the development and review of the initial operations plans to be followed by the players in the exercise.

As noted earlier, the current REDCOM plans call for the use of JTLS to develop the situation prior to the actual start of the exercise. This would entail the involvement of a small number of players from each of the commanding organizational elements of each service participating in the exercise. The JTLS play would take place on a fairly continuous basis for two to three months prior to the participation of the entire group of players in the JESS exercise.

During the months prior to the exercise, REDCOM also assembles the appropriate controller teams for the exercise. The majority of the controllers will come from the player elements in the exercise and from various organizations such as TRADOC in the Army. The controllers will be assigned to REDCOM for temporary duty for a period of two to three weeks. During the week prior to the exercise, the controllers will be trained to use JESS and to carry out the role playing functions of exercise controllers. The typical REDCOM exercise requires several hundred controllers to operate the various workstations 24 hours a day during the exercise.

Ultimately, the database developed through the JTLS play will provide the starting point for the JESS. Once the controllers have been trained and all players have been deployed to their appropriate locations, the exercise will begin. The exercise begins when the JESS is initialized and the players receive their respective operations plans from their commanders. The JESS will run for approximately three to four days. During this time, the exercise is in progress continuously.

The exercise progresses with JESS playing the role of an automated battle board. The corps and division commanders and staff function just as they would in an actual combat situation, receiving information and developing and giving directives to their maneuver, fire support, intelligence, and support elements. At the brigade level, the commanders and staff interface with the JESS and provide appropriate feedback concerning the progress of their maneuver battalions back to division and corps level.

At the completion of exercise play using the JESS, the assistant exercise director conducts his "hot wash" feedback session with the corps commander and selected staff members. Following the exercise, the player units complete an after action report which is forwarded to REDCOM.

As described above, it should be apparent that the joint exercises conducted by REDCOM are extremely complex. The exercises include thousands of players and hundreds of controllers. The model used as the exercise driver (JESS) has limited automatic data recording capabilities at the current time and the number of activities and players occurring simultaneously create a necessity for development of a performance measurement system with a specific focus. It is the focus and structure of the measurement system which will impose some degree of order and understanding amid the "fog of war" which exists in large scale combat exercises.